THE MODEL ENGINEER

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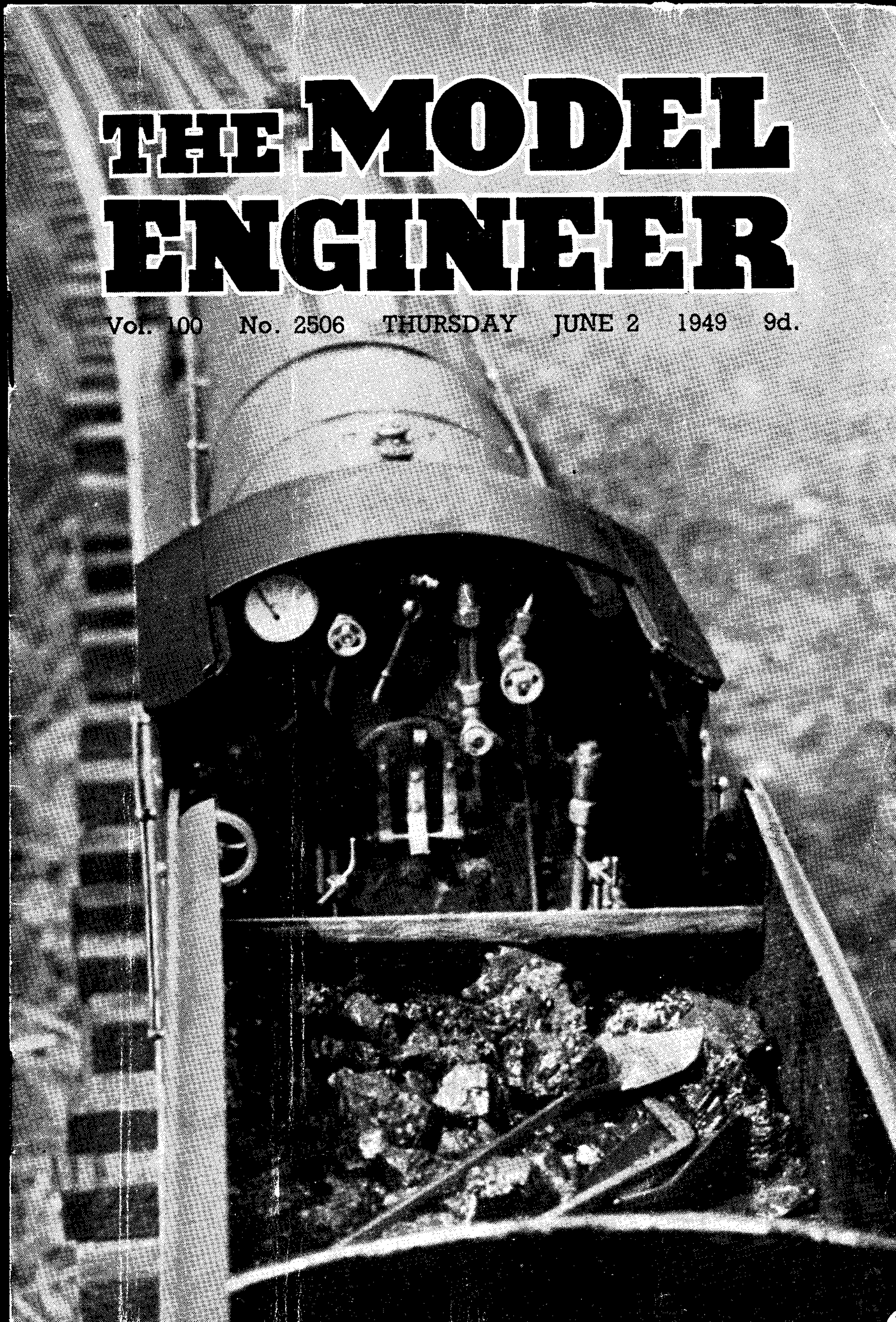


The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

2ND JUNE 1949 VOL. 100 NO. 2506

SMOKE RINGS

Our Cover Picture

● A VERY familiar sight is depicted in our cover picture this week, and to describe it in detail would, of course, be superfluous! The original photograph was taken by Mr. A. R. Turpin, of the Sutton Model Engineering Club, and the engine is a "Hielan' Lassie" built by Mr. G. H. Dickinson of the same club. Notice the neat and convenient arrangement of the backhead fittings, though we would have preferred to see some indication of water and live steam in the boiler.

"M.E." Exhibition Stewards Wanted

● WE SHALL be requiring the services of a number of stewards at THE MODEL ENGINEER Exhibition. Anybody able to be available between August 16th and 29th inclusive should get into touch with the Exhibition Manager, Percival Marshall & Co. Ltd., 23, Great Queen Street, London, W.C.2, immediately.

"M.E." Exhibition Prizes

● THE NUMBER of donations to the Prize Fund is steadily growing, and we tender our grateful thanks to the donors. Mr. Charles J. Hampshire has renewed his annual Hampshire Prize of £2 2s. 0d. to be awarded to the best miniature marine model in 1/32-in. scale or under.

Messrs. A. J. Reeves & Co., of Birmingham, offer a voucher for £5 5s. 0d. for goods to be selected from their catalogue. The section in which this prize is to be awarded has been left to the discretion of the Organisers, but Messrs. Reeves would prefer it to be connected with locomotives from "O"-gauge upwards, or stationary steam engines.

The Quickset Toolholder Co. Ltd., of Birkenhead, have donated a prize of £1 1s. 0d. for, if possible, the best "O"-gauge locomotive, or any worthy piece of mechanical engineering, by a youth up to 19 years of age.

The "M.E." as a Rest Cure

● A LITTLE while ago, we were very pleased to receive a call from a reader who is an old friend of ours, if only because it proved that he was once more in good health after a serious breakdown. He was kind enough to say that, during his recovery, he had spent much of his time looking through his collection of MODEL ENGINEERS, just for the sake of the mental relaxation derived from looking at the pictures and reading the articles. He is sure that this did much to expedite the improvement in his health. We believe that this is not the first time that THE MODEL ENGINEER has served as a rest cure, but our friend was not aware of this; so we were the more gratified to have his unsolicited testimonial. There is something rather attractive about the idea that THE MODEL ENGINEER possesses medicinal properties!

An Editorial Problem

● IT IS natural that many of our readers should take every opportunity of writing to us to express views upon the contents of THE MODEL ENGINEER; and we are glad to have such letters, if only because they indicate that the writers take a friendly interest in our policy and the well-being of THE MODEL ENGINEER. The recent announcement about the increase in our rations of paper has provided just such an opportunity for readers to make suggestions which range from one extreme to the opposite; on the same day, we received two letters which illustrate this point, and in gratefully acknowledging them, we would like to offer some comments on them.

One letter deplores the fact [*sic*] that THE MODEL ENGINEER has become too elementary and seems to take great pains to print "pages of tedious repetitions of descriptions of workshop processes which everybody learnt years ago, and are now to be regarded as nothing else but padding."

The other letter asks if it is not high time to remember the beginner, who is not expert enough, however keen he may be, to make the models described, or to know how to set about it.

To both of these writers, we would point out that our policy is to do all that we can to ensure that "Ours" appeals to and shall serve the widest possible range of interest, from the keenest expert to the rawest beginner. Obviously, this means that we cannot cater wholly for either as a regular policy. We have always to remember that the vast majority of our many thousands of readers are not engineers, though most of them have a natural aptitude for using workshop equipment; otherwise, they would have little or no interest in our hobby, and certainly no incentive to receive ideas on what to make and how to make it.

The surest indication that our policy is at least on the right lines is the fact that, since December, 1948, we have added some 5,000 new readers and the demand is still growing. Our aim must remain, therefore, what it has always been: to do all that we can to help in the promotion and development of model engineering and allied craftsmanship. Detailed descriptions of workshop processes may tend to bore the expert, but are essential as a guide to the not-so-technical average enthusiast; and the *basic* knowledge required by beginners is available in our handbooks. It is, perhaps, opportune to remind our new readers that a catalogue giving full details of these useful books is available, free and post free, to all applicants.

Trade Reports

● FOR SOME time past we have been aware of the difficulties that beset the owner of the small workshop when buying new equipment, and more particularly does this apply to those who, living abroad or at a distance from a large town, have not the opportunity of examining the goods they see advertised.

Although all would accept without question the quality of any product of, say, the Rolls Royce factory, this can hardly apply where some small or unrecognised firm is concerned.

We have often published descriptions of tools and equipment submitted to us by the engineering trade, but these articles, we feel, do not necessarily always give sufficient guidance to an intending purchaser, resident in the Colonies maybe, to enable him to assess the particular merits of the machine in question, together with its accuracy, good wearing qualities, and suitability for his individual needs.

With this in mind, we have asked our contributors, "Duplex," to examine and report frankly on any articles of workshop equipment which manufacturers or dealers care to submit to us under the particular terms governing this scheme, so that their findings may be published in our columns.

We have decided to take this step with a view to helping both the manufacturer and the prospective customer, for we feel that we owe it to our less experienced readers to offer them some measure of guidance in the selection of tools.

Accordingly, we have agreed with "Duplex's" suggestion that the main consideration is the general suitability of the product for ordinary workshop use, and that meticulous accuracy, however desirable, cannot always be expected at a price within reach of a large number of workshop enthusiasts. On the other hand, good finish, a high degree of accuracy, and other desirable qualities will not fail to arouse the favourable comment that they rightly deserve.

A Ploughing Engine Query

● AMONG THE many letters which are still coming in from readers on the subject of steam ploughing engines, there is one from Mr. M. S. Wilde, of Chesterfield. He states that, at the time of writing, there is a Clayton & Shuttleworth single-cylinder ploughing engine lying derelict in a field near Chesterfield. This engine carries the maker's number 31950, but no date, and Mr. Wilde would be grateful if any reader could give the date of construction.

The "M.E." War Surplus Competition

● THERE HAS been some inevitable delay in judging this competition due to the varied nature of the entries, all of which were interesting and ingenious. In addition to the original award of two guineas, sent to us by an anonymous donor, we are indebted to one of our trade advertisers for three further awards of one guinea in the form of vouchers to be exchanged for goods. The prize winners are as follows :—

1st Prize of Two Guineas :

Mr. E. Killey, of Romford, for his description of a model electric crane constructed mainly of surplus material.

Vouchers for One Guinea each to :

Mr. N. H. Naish, of Folkestone, for a photo-electric exposure meter.

Mr. F. Almond, of Hexham, for a petrol engine starting and running-in device, and

Mr. S. H. Rutherford, of Wembley, for a burglar alarm and insulation tester.

The articles describing these entries and several others by competitors will be published in THE MODEL ENGINEER as soon as possible.

The "M.E." Improved Projector

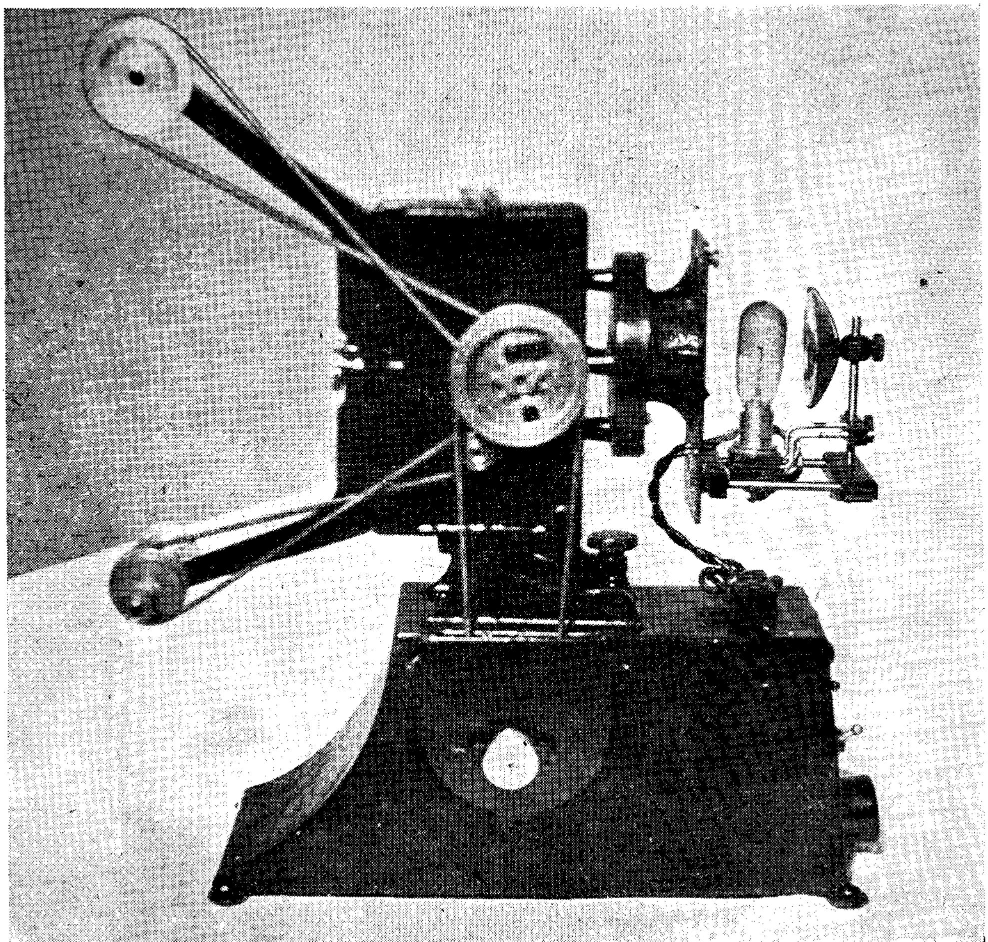
Experiments and advantageous improvements

by W. H. Parsons

WHILE making this machine from equipment supplied by Messrs. Roox Products and other sources, it became apparent to me that the latest machine, although in an experimental category, is a solid job and of good design.

Unfortunately, my knowledge of projectors was practically nil, and the project gave much room for thought and interesting experience. However, after 22 months' interruptions, the projector was finally finished, and a visit made to the local library for information on projection, machine setting and technicalities. The results of my enquiries were reasonably good, but I feel sure that books are urgently required on the fundamentals and principles of projectors and projection data. That is, in respect of 9.5 mm.-16 mm. silent and sound projectors. Suggested scope would cover for instance:—Lamps, Shutters, Cam Actions, Lens, Screens, Films, Splicing, Noise, Voltages, Resistances, etc.

Undoubtedly there are many engineers and amateurs making or struggling along with



The driving side, without lamp-house cover

projector construction, owing to its increasing popularity. Projector construction is most interesting, and gives unlimited pleasure as well as facilities for education when the machine is completed. In view of this, and as a guide and help, I give the following information as based on my own experience with the new "M.E." Improved Home Projector :—

(1) Spool Drivers

(a) 9.5 mm. size. The spool faces of these drivers need recessing $\frac{3}{8}$ in. diameter $\times$ $\frac{1}{32}$ in. deep at centre to accommodate brass bushes in most film spools. Also, the spool driver-pegs should be $\frac{1}{64}$ in. less in diameter than stated on the blueprint.

(b) 16 mm. size. Two extra spool drivers are required to suit spools with square hole location in both flanges. This means making two more, as shown on blueprint, except that square ends are not turned down.

(2) Spool Rewind Pulley

The outer face can be recessed on the lathe, surplus metal removed and an ornamental finish given to the pulley.

(3) Flywheel and Changeover Lever

A 5/32-in. diameter ball-bearing can be used instead of $\frac{1}{8}$ in. diameter size, as stated on blueprint. This automatically gives top 2-B.A. tapping and a more positive location on changeover lever, especially as a larger internal spring can be used.

(4) Gearbox

(a) 3-B.A. countersunk steel screws are more satisfactory than 4-B.A. screws for securing gearbox cover.

(b) To give easy, quick and extra grease loading, an extra O-B.A. tapped hole should be put in the top of the gearbox, and an ornamental brass plug knob made to suit accordingly. This addition saves uncoupling and removing gearbox cover.

(5) Top Film Sprocket Guard

An adjustable film guard was made out of 1-in. diameter brass tube and fastened to sprocket spindle bush by means of a grub-screw. This is most essential, as the finishing end of film tends to spring over top sprocket and become badly ripped in top sprocket teeth, which are travelling in reverse direction.

(6) Film Guide Plates

It is advisable to make precision ground block gauges of 9.5 mm. and 16 mm. widths respectively, for checking recesses when machining guide plates. These same gauges are useful when making a twin splicer for 9.5 mm. and 16 mm. type films. By the way, direct pressure clamping on film splice is far superior to spring pressure. Pathene liquid takes about five minutes to set, and can be recommended. Also, an Ever-Ready safety-razor blade is ideal for scraping off film emulsion, prior to splicing.

(7) Film Pressure Plate

These plates were made out of phosphor bronze instead of brass, to give hard and smooth surface. Finger size ornamental caps (brass) will be found far better than 8-B.A. nuts (spring and gate locating pillars) when changing over film sizes.

(8) Banjo Housing

It will be found an advantage to bring the four fixing holes as near to the shaft hole centre as possible. The reason is that it is more advantageous to file surplus metal off the square base, than remove clearance metal from interior of motion housing, when fitting latter to gearbox and cam action.

(9) Motion Housing

Fixing to gearbox and relative importance :—

(a) First calculate claw penetration by means of centre-lines (on paper) in respect of the gearbox, claw action and motion housing.

(b) Then scribe centre-lines on components accordingly, and file or mill etc., banjo and motion housings until necessary clearances are obtained in respect of : banjo to motion housing—cam frame action to interior of motion housing when in tentative position.

(c) Check again for clearances with the addition of the film guide in motion housing, also with claw frame fastened to cam frame and cam on shaft position. Paint interior of motion housing dull cellulose black.

(d) Counter-check alignment centre-lines on motion housing and condenser housing before fixing motion housing to gearbox.

(e) It would appear more beneficial to drill the lug hole for the bottom film guide hinge-pin last, the reason being due to lack of film guide adjustment, once the motion housing is secured to gearbox. (Top film guide is mounted on an eccentric bush for adjustment.)

(10) Claw and Cam Frames

It is most advisable to check commencing and finishing stroke of claw travel, by means of the film guide aperture when set by the masking lever. The reason for this is to find out whether film guide aperture is central with objective lens and to avoid diffusion on the screen. Elongate claw frame fixing holes (if necessary). A suitable step-down plug gauge can be made to check aperture from motion housing bore.

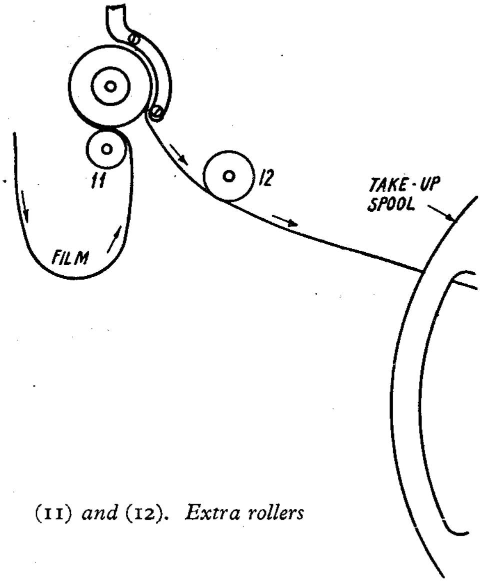
(11) Bottom Film Sprocket

An extra film guide roller fitted close to underside of bottom sprocket will be found

invaluable for new 16 mm. films, or if there are any irregularities in the bottom sprocket or shaft.

(12) Bottom Film Sprocket Guide and Take-up

Another extra film guide roller fitted between bottom sprocket and take-up

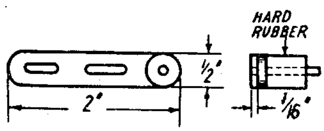


(11) *and* (12). *Extra rollers*

spool will stop the lower film guide being lifted from sprocket, in the event of varied film take-up, especially in respect of 16 mm. films. A $\frac{1}{16}$ in. thick triangular plate can be made to hold this roller and one previously mentioned. This adaptation is secured to the bottom sprocket shaft bush.

(13) Chain Adjuster

An internal chain adjuster fitted with a hard rubber roller, will save resetting of top film guide. In any case, it is advisable to take the gearbox cover off when adjusting the chain.



(13). *Internal chain adjuster*

(14) Lamp Connectors

The addition of two small twin terminal connectors, mounted on top of base and under lamp house, will be found beneficial. One connector is used for the 12 V lamp and transformer supply, whilst the remaining connector can be used for a separate lamp supply, such as 100 V or 110 V, the lamp and leads being changed over accordingly. Single and twin connectors can be used when wiring interior of base, and thus enables easy extraction of transformer, motor plus resistance.

(15) 230 V Plug Socket

It is advisable to mount a small 230 V - 5 amp. twin-plug socket underneath the two switches, for convenience in coupling up to the supply. The supply lead can then be packed separately, and also avoids fraying of insulation in base outlet hole.

(16) A.S.S.C. Lamp Holder

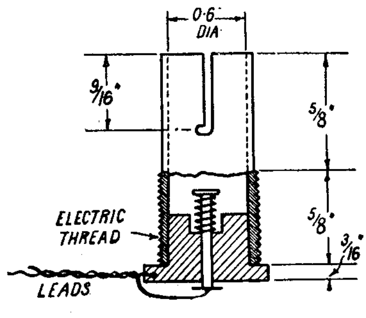
This type of standard holder allows too much lamp movement or tilt, and the lamp requires repeated checking; neither will it stand excessive heat. A specially made extended and smaller internal diameter holder is very successful, and will stand heat if a hard bakelite boss is incorporated with a centre contact, spring loaded.

(17) Lamp-house Cover

It is advisable to drill ventilation holes at the top as large as possible (alternately); also, both sides of light trap plate can be bent down considerably, thus improving air flow, and still without light loss. (About 45 degrees bend.)

(18) Condenser Fixing

The condenser lens should nearly touch and be almost flush with rear machined face of condenser housing. A lens spacing-piece carefully parted off from suitable thin brass tube, will be found ideal for spacing the lens. Naturally, the thin brass tube should be of slightly larger diameter than lens diameter or condenser bore.



(16). *A.S.S.C. holder*

(19) Shutter Disc

It was found that the film cut-out section was best determined by use of the screen with film projected, and machine turned slowly by hand (flywheel). Minimum amount of "cut-off" without visible movement of film on screen.

(20) Film Sprockets

All film sprockets should be carefully checked against *new* 9.5 mm. and 16 mm. films, before trying out machine. Otherwise, new film will ride off sprockets and/or become damaged.

(21) Objective Lens Holder

A knurled locking-pin (brass) has advantages over the ordinary fixed aluminium locating-pin, unless the lens holder is a really good sliding fit.

(22) Claw

An accurate template was first made before drilling and filing shape of claw. It is easier to mark out a template from plate than on the turned claw in its first stage. The centre hole is used for location.

(23) Speed Control (Elec.)

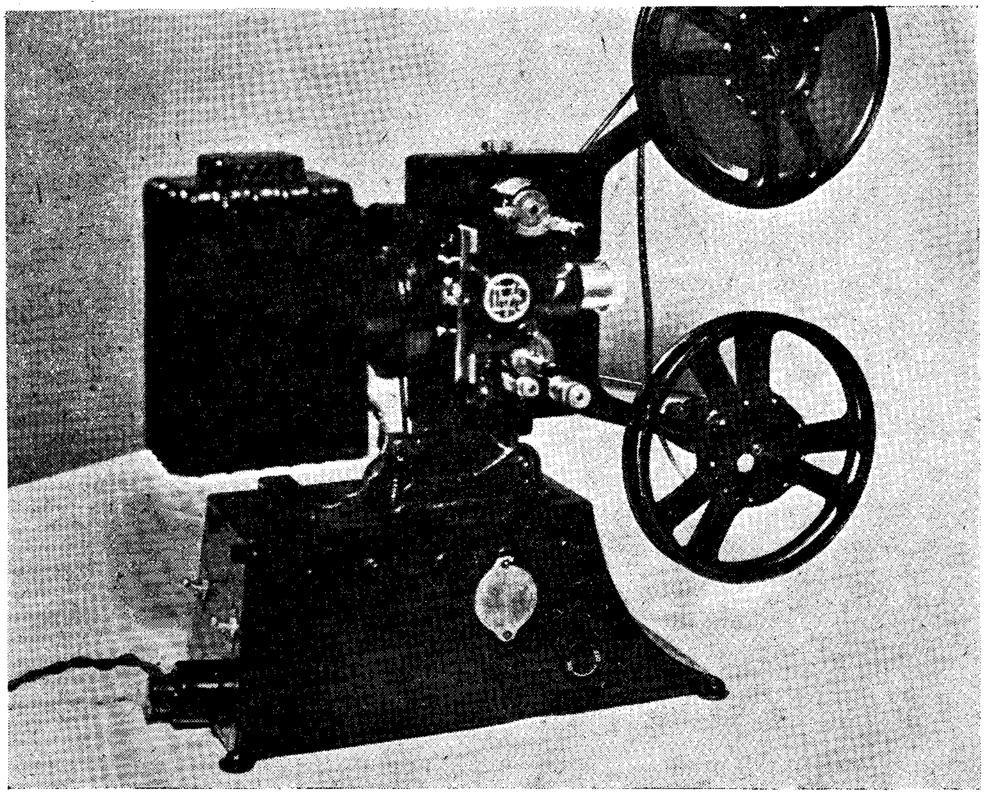
A hole needs to be drilled in the side of the base and of slightly larger diameter than the knob, as the knob is not detachable. Special interior fixings are also required, otherwise the bakelite base flanges may get broken upon assembly. A 1/32 in. thick triangular steel plate and three 6-B.A. end tapped pillars, make a good fixing method.

(24) Motor

An extra hole should be drilled in the motion housing side of the base, to allow lubrication of the motor bearing. A suitable disc cover completes the appearance. Bearing caps can be turned around to suit.

(25) Motor Pulley and Mech. Speed Control

After experimenting, a suitable size of driving pulley was decided upon, and with the addition of a simple mechanical speed control, *any* speed became obtainable. A $1\frac{1}{2}$ in. diameter pulley gives the flywheel 1,000 revs., which is 40 revs. above normal. The mechanical speed control is fitted on the outside of motor drive base cover, and consists of a simple spring-loaded friction disc, which is adjustable. When in operation, the friction disc bears very lightly against motor pulley boss face.



The motion side, with rewound reel

(26) Lubrication

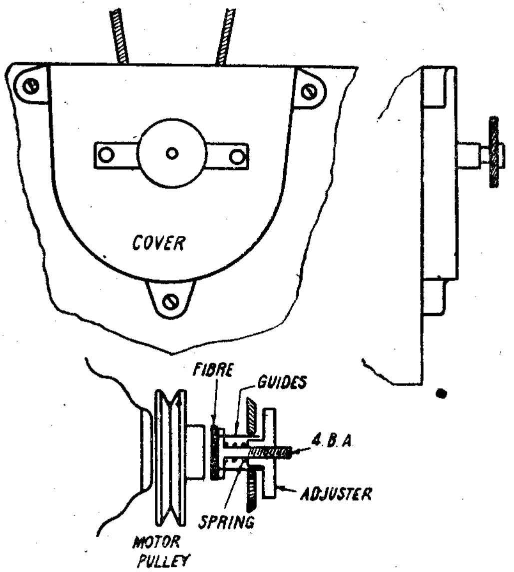
Sewing-machine oil is suitable for external parts, whilst the gearbox is packed a full third with a light grease. "Slipco" superfine grease is suitable and obtainable from most motor-cycle or car dealers, etc.

(27) Setting Lamp and Reflector

(a) First project film on to screen and set masking lever until film is centred.

(b) Carefully take film away, including objective lens holder, lamp-house cover and reflector.

(c) Adjust lamp until filaments are clear and on centre of screen, then lock.



(25). *Mechanical speed control*

(d) Fix and adjust reflector until a clear replica filament is obtained on the screen, then carefully superimpose and lock.

(28) Film Splicer

Instead of buying a dual film splicer for about £2, this can be easily made for next to nil. The two film guide gauges and two pieces of good film about 6 in. long, can be used to assist in construction. All that is needed, is a piece of $\frac{1}{16}$-in. brass plate 6 in. × 4 in. for base, 4 pieces of steel 6 in. × $\frac{1}{4}$ in. × $\frac{1}{16}$ in. for film guides, several small brass nails for perforation location, and two pieces of $\frac{1}{2}$-in. × $\frac{1}{4}$-in. steel for splice clamps. Solder nail heads and reduce surplus with " snips."

(29) Projector Base Pad

A piece of $\frac{3}{8}$ in. thick white felt 15 in. long × 8 in. wide, will be found very useful as an additional shock or vibration absorber.

(30) Screen and Lamp

The " M.E." projector will throw a very good picture from 10 ft. to screen with ordinary lens. A " Staybrite " silver screen 40 in. × 30 in. (£2 7s. 6d.) is quite suitable.

The 10 V lamp recommended is very good, but suggest that a 12 V - 100 watt lamp, as supplied in the " Gem " projector, is worth trying.

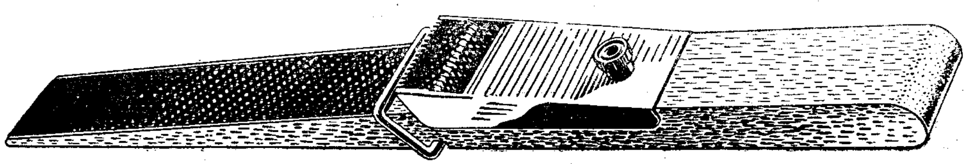
Conclusion

The estimated cost of the projector is in the region of £25. I would strongly advise cine enthusiasts to join the British Film Institute, of which I am a member, and/or The Scientific Film Association. There are also numerous cine film libraries and the monthly issue of *The Film User*, is very helpful.

Material for Visual Education—a book recommended by the *Daily Mail*, and edited in co-operation with Exeter University—is also strongly recommended as a source of information on films—film strip and slides, etc.

A Useful Abrasive-Strip Holder

THE common practice of wrapping a strip of abrasive cloth round a file or piece of wood has many disadvantages in practice, and attempts are often made to improve upon it by various improvised forms of holders. A very ingenious strip holder has been submitted to us by Mr. H. G. Drinkwater, of 109, Middlemore Road, Northfield, Birmingham, 31. It consists of a suitably shaped strip of hardwood, with a simple tensioning device which holds 1-in. strips of abrasive cloth securely. The strip can be reversed end for end so that practically the whole length is usefully expended, and a strip can be changed in a few seconds. It is supplied with one strip each of fine and medium grade emery-cloth for 2s. 6d.



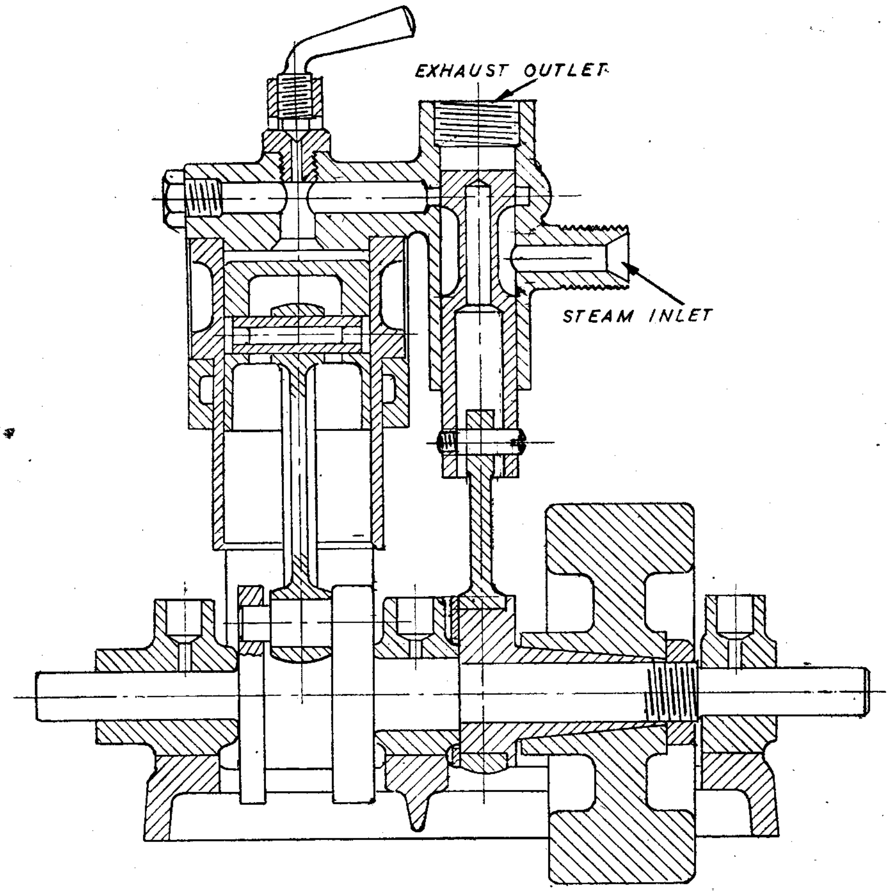
*UTILITY STEAM ENGINES

by Edgar T. Westbury

AMONG the many comments on this series of articles which have been received from readers, some interesting questions have been raised on specific items or aspects of model steam plant design. Several readers have asked for information on the design of horizontal mill engines and other stationary steam engines, suggesting that these have been sadly neglected in recent years. I must admit that this is going beyond the originally intended scope of this particular discussion, and while I am willing to extend it to embrace any type of steam engine which is likely to be of general interest, I should like some further guidance as to which types are in popular demand.

*Continued from page 621, " M.E.," May 19, 1949.

It would, however, appear to me that some of my readers have not appreciated the distinction—which I was at some pains to point out in my introductory notes—between " utility " and " prototype " design ; in other words, between engines designed simply to perform a definite purpose, and true, or at least characteristic, models of engines in full-size practice. Whereas, in the former case, I have been concerned mainly with first principles, and sound mechanical design, without any very scrupulous regard for scale proportion or fidelity of appearance, these matters assume paramount importance in the latter case. I am in sympathy with the readers who would like to see more working drawings and instructions for building true prototype engines in the " M.E." ; but I am by no means certain that I am the best person qualified to supply this information.

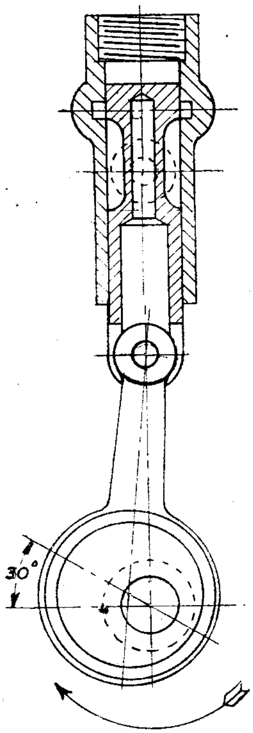


Side sectional elevation of " Spartan " engine, adapted for piston valve

Compounding

One reader, in commenting on the types of twin engines illustrated in these articles, raises the question of comparative merits of simple compound engines. He is of the opinion that the greater efficiency and economy of the compound engine are important considerations from the utility point of view, and further suggests that twin-cylinder " simple " engines are never seen in full-size practice.

There is, of course, no doubt whatever about the advantages of compounding in two, three, or even four stages in really large engines, but it is by no means certain that these are maintained in small engines when working under the conditions normally encountered in model practice. It is true that a compound engine will *work* reasonably well in any size, but whether it obtains the superiority over the simple engine which should theoretically be possible, is quite another matter ; and the data available on the performance of small engines is not sufficient to throw much light on this question.



POSITION OF ECCENTRIC WITH CRANK ON T.D.C.

Timing of eccentric for normal purposes

Incidentally, the suggestion that simple engines of more than one cylinder are never seen in full-size practice is not strictly correct ; apart from locomotives, where they are the rule rather than the exception, many engines for auxiliary purposes, both in marine and stationary installations, are made that way, though the object in doing so is usually to ensure starting and facilitate control, efficiency being a secondary consideration in such cases. It is, perhaps, significant that, apart from one or two notable exceptions, locomotive engines have never been really enthusiastic about compounding, and this applies both to full-size and model practice. There have, however, been many very fine compound engines fitted to model boats, and most of them have served their purpose quite well, besides being fully justified by reason of their fidelity to prototype practice.

If one decides to adopt compounding in utility engines, I recommend that they should be run on fairly high steam pressure, with moderate but not excessive superheat—just sufficient to offset condensation losses—and very free exhaust, or better still, a condenser which really works and is capable of maintaining a substantial degree of vacuum.

Valve Port Sizes

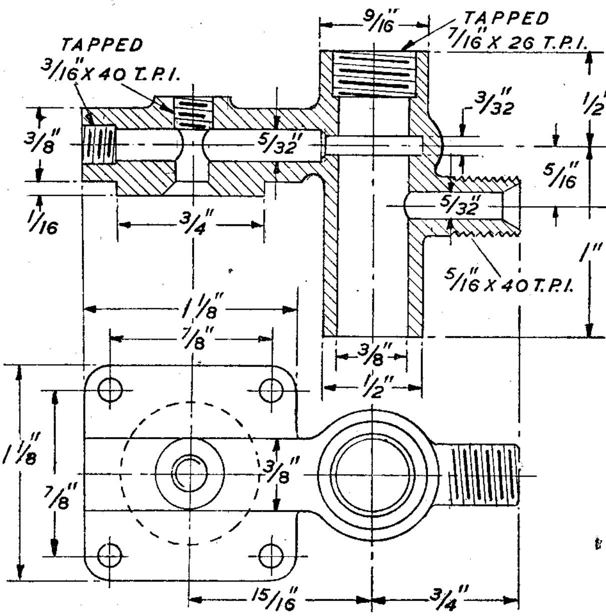
Another reader has criticised the design of the valve ports in the " Trojan " and " Warrior " engines, which are said to be small in comparison with those now popular in locomotive cylinders of proportionate size. It should, however, be remembered that the conditions under which these two engines normally work are by no means comparable with those encountered in locomotives. The latter are invariably run under manual control, and the regulator is rarely opened wide for more than short intervals. Moreover, when once the initial resistance and inertia of the load has been overcome, the valve-gear is normally linked up, which has the effect of reducing the effective valve port area and wire-drawing the steam supply to some extent.

In the engines above referred to, however, no provision is made for linking up, and the regulator—if one is fitted at all !—is usually kept full open ; while the initial starting load is light, whether the engines are used for marine or stationary duty, there is always a dead load when the engines are performing their normal duty, comparable with that of a heavily-loaded locomotive climbing a gradient in full gear. Steam consumption, in such cases, is limited only by the amount the boiler can produce, and with abnormally large ports, the tendency is to allow steam pressure to drop, with a corresponding loss of efficiency. A reduction of port area, even though it may lower the potential cylinder performance, is often beneficial, by enabling the steam pressure to be better maintained.

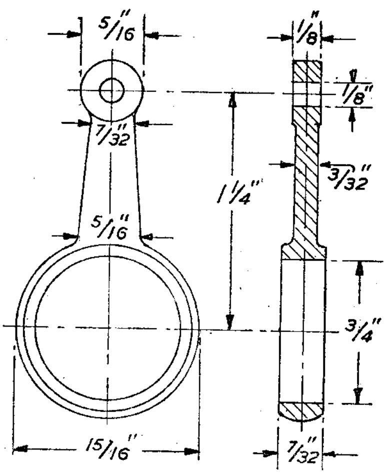
This is not an argument in favour of small ports, as such, but it cannot be denied that there is an optimum size of port to suit the particular conditions of working, and in relation to the steam generating capacity available. The common practice of judging the efficiency of a steam engine by what it will do when tested on a large boiler of virtually unlimited capacity, is a fallacy ; it should be tested in connection with its own boiler and burner, in order to provide a true assessment of what it will do under actual working conditions. Efficiency and economy are really synonymous terms when applied to a complete steam plant.

A Modified "Spartan" Engine

Although the design of the "Spartan" uniflow poppet valve engine has interested many readers, it has been found that there are many others who prefer to stick to more orthodox principles, and object to both of its salient features—namely, the use of a poppet valve for steam admission, and the complete elimination of a mechanically-operated exhaust system. The more conventional piston-valve type of engine, in which the one valve controls both steam admission and exhaust, engines, and I am prepared to defend the claims of the latter type, but individual readers are entitled to their opinions and preferences, even if these are based on nothing more than convention and prejudice. It is freely admitted that the piston-valve type of engine has a much greater flexibility in respect of working pressure and running speed, and it is capable of very high cylinder performance, though with an inferior economy of consumption, compared to the poppet-valve engine.



Details of piston-valve type cylinder-head



Eccentric strap and rod

and is operated by a simple eccentric, is better understood by many constructors, and apparently they seem to consider that "the devil you know is better than the devil you don't know." It is further pointed out that the principle on which this engine works is not new, and that it was tried and found wanting long ago. To deal with the last criticism first, no claim was ever made that it was original in principle, though the details of the design, which often make all the difference between success and failure, have been carefully worked out to produce a sound mechanical design with utmost simplicity of construction. It is also admitted that some of the early forms of uniflow high-speed engines were not very successful, though to say that they were *all* found wanting would be much too sweeping a statement. Some very successful results were obtained with them in early model speed boats, and I saw one of indeterminate age, and by no means pretentious design, working very well at the recent Sheffield Model Engineering Society's Exhibition.

I have already discussed the relative merits of the piston-valve and poppet-valve types of

When the "Spartan" engine was designed, I visualised the possibility that some constructors might wish to equip it with a piston-valve instead of a poppet-valve, and arranged it so that the conversion could be carried out with the minimum difficulty. In view of the fact that the piston-valve controls both steam and exhaust events, its use eliminates the necessity for the uniflow ports, but they are nearly always found beneficial in ensuring the early release of exhaust and elimination of back pressure.

Details of the components employed in conversion are given here, and it will be seen that apart from the alternative engine components, no structural alteration of the engine itself is called for. This introduces the possibility of making performance comparisons with the two forms of valve-gear in the same engine, which should help to settle the question of their relative merits.

It will be seen that the engine is fitted with a new cylinder-head, having a much larger steam chest extension, bored to take a piston-valve. The latter is operated in the usual way, by means of an eccentric-rod and strap, from an eccentric

sheave which takes the place of the cam, and may, in common with the latter, be made integral with the split collet on which the flywheel is mounted. As will be seen from the end-on view of the eccentric gear and piston-valve, the arrangement and timing of the valve are fairly normal, the steam being admitted from the side, between the "lands" of the valve bobbin. This is equivalent to "inside admission" in a double-acting piston-valve engine, and avoids any unbalanced steam pressure tending to move the valve endwise. Outside admission, as commonly employed with flat slide-valves, would be equally effective in respect of port control, if the valve is appropriately timed, but this would entail admitting the steam to the top end of the valve chest, and produce a constant downward pressure on the valve, with unnecessarily high loading on the eccentric strap.

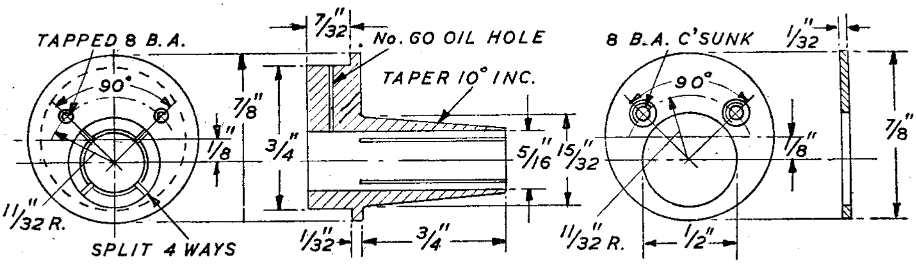
Cylinder-head

The machining of this component is generally similar to that of the poppet-valve head, except that care is more essential in ensuring that the axis of the valve chest is parallel with that of the cylinder, and the finish of the bore must also be highly accurate. If leakage past the piston-valve is to be avoided, exact parallelism of the bore throughout its length is essential, and it is recommended that lapping operations, similar to those employed in small i.c. engines, should be adopted. The recess to form the annular steam port may call for the use of a specially-made internal recessing tool, which should have a shank about $\frac{3}{16}$ in. diameter, and a squared or slightly rounded-off cutting edge 3/32 in. wide; this may be made by turning down a piece of $\frac{3}{8}$-in. silver-steel, to the above shank diameter, but leaving a 3/32-in. collar on the end, which is afterwards filed to shape, then hardened and tempered. The position of this port is, of course, highly important in relation to the setting of the piston-valve, but the latter may be marked off *in situ* when the engine is assembled.

To machine the steam inlet union, the head may be mounted on an angle plate, using the flat underside of the cylinder spigot as a bolting face. It will be noted that the top end of the valve chest is tapped $\frac{7}{16}$ in. fine thread to take the exhaust pipe, which should be not less than $\frac{1}{4}$ in. in the bore, and carried away as directly as possible to avoid back pressure. When drilling the horizontal steam passage across the top of the head, care must be taken not to run the drill right into the bore of the steam chest, but only just into the annular port.

Eccentric Strap

This may be made from a bronze casting, and machined on the faceplate in much the same way as described for the connecting-rod. Here again, the distance between the eye centres affects the timing of the valve ports. The sideways alignment of the eyes should be carefully watched both in the machining and assembly stage, but it should not be necessary to offset the rod by bending, which is undesirable both from the aspect of appearance and mechanical efficiency.



Eccentric sheave and collet

Eccentric Sheave

A piece of steel bar large enough to form the sheave should be eccentrically chucked, and turned down on the end to form the taper collet, taking pains to ensure that it fits the flywheel bore. The centre hole is also drilled and reamed at this setting. Before splitting the collet sleeve, it is fitted to the flywheel and temporarily held in place by a $\frac{1}{4}$-in. bolt through the bore. The flywheel can now be used as an eccentric turning jig, by clamping it to the lathe faceplate.

After turning the eccentric sheave to a close working fit in the eye of the sheave, the bolt may be removed to enable the back face to be machined right across. If the taper is a good fit, there will be little risk of it shifting during this operation. Finally the collet sleeve may be split, in the same way as the original cam sleeve. It will be necessary to make some provision for keeping the eccentric bearing lubricated, and the best way will be to drill a small hole through the sheave and into the shaft, to communicate with the centre oil passage in the latter, after the position of the eccentric has been set.

A retaining plate is fitted to the inner side of the sheave by two 8-B.A. countersunk screws, and it will be seen that the centre of this is bored out to clear the boss of the main bearing, so that no register is provided to keep this hole concentric. It should therefore be drilled $\frac{5}{16}$ in. diameter to begin with, and a $\frac{5}{16}$-in. bolt, or a piece of $\frac{5}{16}$-in. diameter bar, used as a mandrel to keep it in line with the sheave while marking out and drilling the screw holes. Afterwards, the hole is opened out to $\frac{1}{2}$ in. diameter, and should it then foul the boss of the bearing, the latter may be machined over the outside to clear. It will be noted that the extension of the bearing casting, which forms the tappet guide when using a poppet-valve, is no longer required, and must be cut away; alternatively, a casting identical with that of the outer main bearing may be used in this position.

(*To be continued*)

Models and Magic

by Donald Stevenson

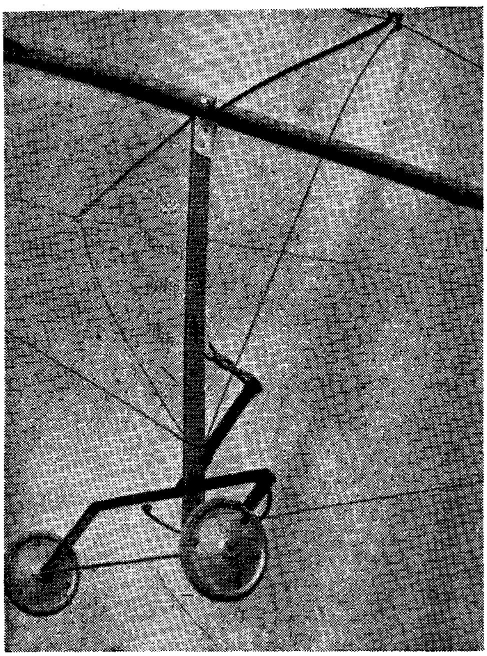
THE subject for this article is an unusual and mysterious personality, none other than Chung Ling Soo, the famous "Chinese" magician. His beautiful and spectacular performance, with its lovely scenery and costumes and specially suitable music, was one of the finest magical shows ever produced. From the technical point of view it has never been surpassed, and he has truly been called the Master Magician.

In private life he was W. E. Robinson, an American, but his make-up was so perfect that it was many years before the secret was allowed to leak out that he was not a Chinaman. A number of his assistants were real Orientals, including one who acted as his interpreter because, on the stage, Chung Ling Soo pretended he could not speak English, a masterpiece of showmanship.

He was a very fine mechanic and woodworker, and was especially interested in model making.

At one time he shared the expense of a workshop with the writer, where many experimental model aeroplanes were turned out in the early days of flying, and a number of other inventions were developed.

Chung Ling Soo in one of his magnificent Chinese robes



Springing of front wheels of bamboo and cane fuselage

In addition to his interest in model aeroplanes, however, he often made cardboard "mock-ups," and then working models of new illusions before he built the full-size apparatus. The writer can remember sitting at a large assembly bench with him in the workshop mentioned, sometimes until two or three o'clock in the morning, helping him to puzzle out cardboard "mock-ups" until the floor and everything else was covered with cardboard cuttings, seccotine, bits of wire, string and cotton.

The workshop contained one treadle fretsaw, one treadle circular saw, a $4\frac{1}{2}$-in. screwcutting lathe, and pillar drill and emery wheels, also treadle-driven, a wood bench with vice, metal bench with vice, large assembly bench, a small forge and a good supply of wood and metal hand tools. All the small tools were hung on the walls in their own special places, and there were also shelves all round the workshop. Under these shelves were fixed glass jars with screw tops, the tops fastened with wood screws so that it was only necessary to give a jar a turn and it came away from the lid which was left fastened to the underside of the shelf. In the jars were nails, screws, nuts, bolts, washers, split pins, etc., of all sizes, including small model nuts and bolts down to $\frac{1}{16}$ in. in diameter. There was also a separate room which was used as a drawing office.

Chung Ling Soo had a great liking for plywood, which was not in such general use in those days,

or of such good quality as can be obtained today. Often he would glue two or even three pieces together when he wanted to make something that he used to call, good and strong!

The mechanism required for some of his illusions took a lot of thinking out, as it often embodied mechanical motions of a most intricate nature. Sometimes the whole workshop would be a tangle of wires and strings connected to a mass of peculiar shaped levers, and with knobs and switches all over the place. Woe betide anybody who touched any of them before the experiment was completed.

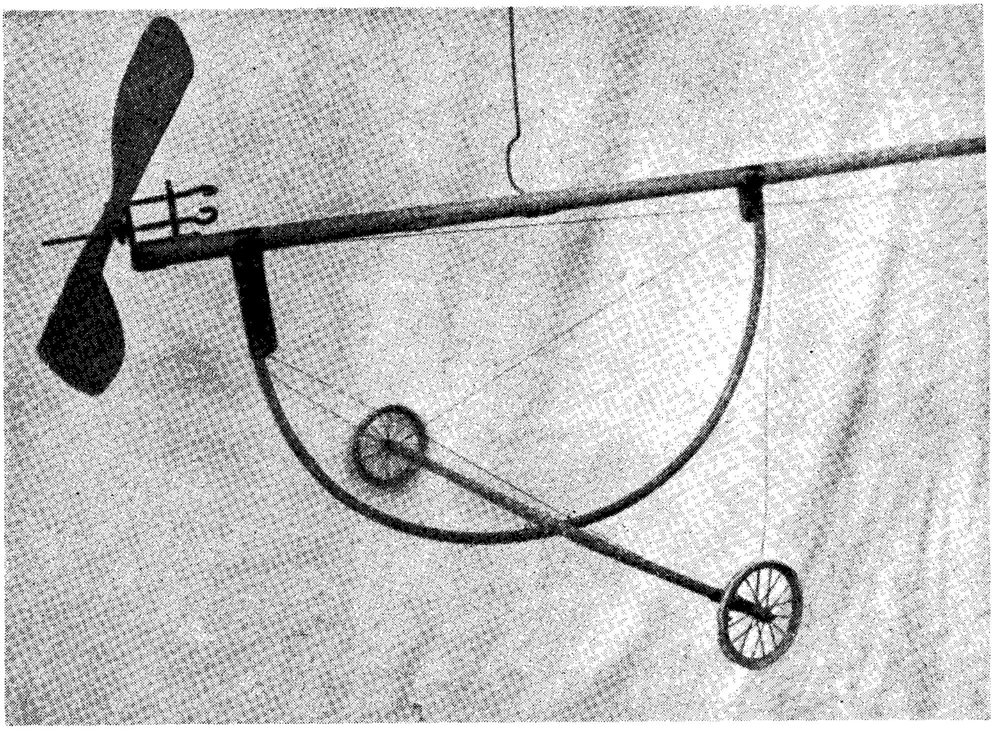
When he was engaged on the model of a new illusion Chung Ling Soo would work for hours without saying a word, as he became so engrossed in what he was doing.

At times he would rush into the workshop saying, "I've got a ken o' crazy idea that I might ..." That was a favourite expression of his, then he would describe what he had got in his mind. His "crazy ideas" generally turned out to be exceptionally clever new illusions.

About 1911 we were approached by a new firm, which had been started to sell model aeroplanes and parts in a number of shops about the country. Until then they had imported all their goods from France, but had heard of some experimental model aeroplanes made in our workshop. They asked if some special models could be designed that would really fly, and be easy to handle. Six different types were eventually produced and tested, all of them flew exceptionally well for those days and were constructed so that they could be folded up for transport and prepared for flying in a few minutes.

The result was the offer of an order for a weekly supply of three flying scale models of the cross-Channel Bleriot, thirty-six large flying models, and twelve each of four other smaller and cheaper types. In addition, a number of propellers and other spare parts were required. After some hesitation it was decided to accept the order, several men and youths were engaged to carry out the work, and so, out of our private experimental workshop, started one of the first model aeroplane factories in this country. This work continued until the commencement of the 1914 war, but we still made models there ourselves for our own pleasure and satisfaction, and carried out a considerable amount of experimental work. We were so keen on this work that we often spent on it a great deal more than the amount of the profits we obtained from the models made for the trade.

It was extraordinary the amount of time Chung Ling Soo found possible to spend in the workshop. When he was performing in London he generally put in most mornings there, and when he was in the Provinces he would travel up during Saturday night, after his show was over, spend Sunday in the workshop, and journey



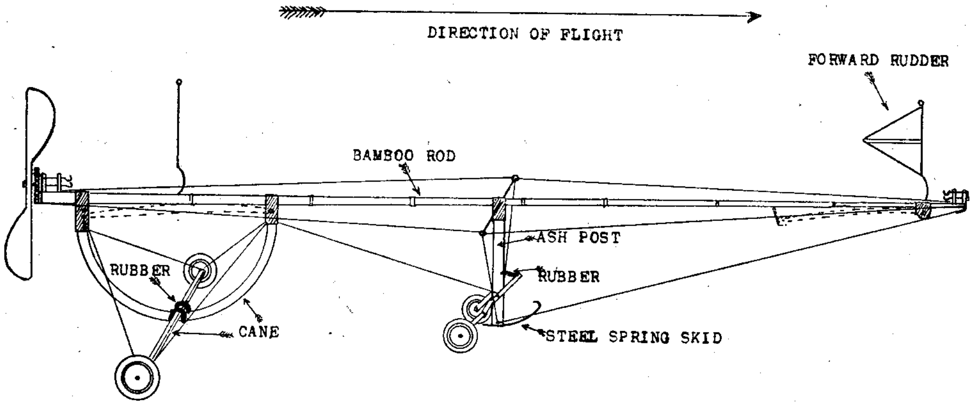
Details of rear wheels of bamboo and cane fuselage, showing springing

back to the Provinces during Sunday night. In his performance he used about eight tons of apparatus, etc., including some of the most beautiful mechanism one could wish to see, and a lot of it was worked out and experimented with, in model form, in that workshop. He employed in his show mechanics, electricians, carpenters, as well as his stage assistants, secretary, and musical conductor. He was one of the greatest of music-hall stars and received a tremendous ovation wherever he went, but by nature he was a quiet, modest, retiring man and was never happier than when working away at models with his own hands.

With the exception of technical books and papers on magic, his favourite journal was THE MODEL ENGINEER. The writer still has in his possession parts of some of his models including a large bamboo fuselage about 6 ft. long, with a special spring; tricycle undercarriage, made in 1907.

In the illustration of the fuselage or framework, dotted lines show where and how the planes were fixed, the angles of incidence of both were adjustable. The model was driven by a 15-in. propeller at the back, which was powered, through gear wheels, by two skeins of rubber. The framework is carefully stayed with wires so is very strong and only weighs 13 oz. complete with wheels, but excluding the rubber. The rudder is in front.

The model flew about 300 yards, which was an exceptionally good flight in those days. The planes were flexible at the tips, that is beyond the stay wires, so gave to any wind gusts, and this added to the stability of the model in flight.



The 6 ft. long bamboo and cane fuselage with sprung tricycle undercarriage

The stay wire under the front half also acts as a skid as far as the small spring skid under the post in the middle, and this passes the load on to the pair of small, well-sprung wheels pivoted on the post. At the rear end there is a semi-circular cane skid ; at right-angles to this and attached to the main bamboo member with wires, is a springy cane axle held on to and above the skid with rubber, giving a wide and very resilient wheel base.

The whole model was very carefully thought out and could be folded completely flat in a few moments, but, in spite of this, it was so exceptionally strong that it stood continual rough usage, and the fuselage never came to grief. It embodies many ideas that could be used to advantage on models of today, although it was designed and made over 40 years ago.

For the Bookshelf

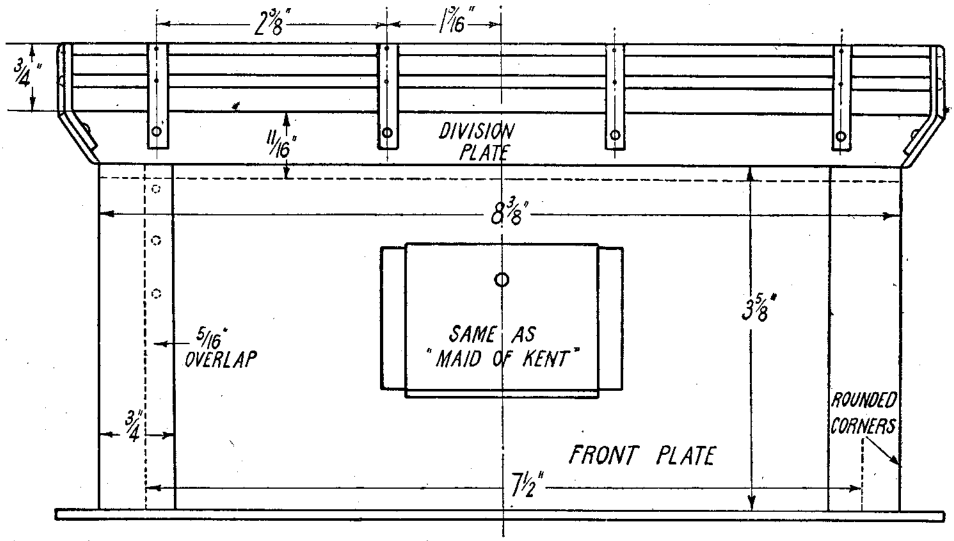
Ship Modelling Hints and Tips, by " Jason " (Lieut.-Comdr. J. H. Craine, R.N.R.). Percival Marshall & Co. Ltd., London, W.C.2. 10s. 6d. 117 pages. Royal octavo.

As explained in the preface, " this is not a book to guide you specially on one particular model but rather to be of help in making any model." The chapters contain hints on various methods of building hulls, the materials which should be used for the various parts of a ship model, the making of ropes, including a drawing of a machine for " laying " ropes in one's own workshop, and painting and finishing the model. Useful information is given with reference to guns, anchors, flags, and the hull details of various periods. An interesting chapter deals with miniature modelling, and another with a discussion on seas and the setting of a scenic model in a suitable sea. A useful table is given, showing the amount of sail which would be carried by the different types of ships under conditions from a calm to a full gale. Yet another chapter deals with cases, both for transport and for exhibition purposes. In fact, the book is just what it sets out to be—a collection of hints and tips as to ways and means, and items of information likely to be useful to ship modellers of all types ; all written in this writer's well-known racy style. The line drawings, which are a feature of the book, were prepared by Mr. G. F. Campbell. Some photographs of notable models are included. The book concludes with a comprehensive bibliography ; it should be on every ship modeller's bookshelf.

Tender Body for the " Minx "

by " L.B.S.C."

THE accompanying illustrations of the tender body for the " Minx " show all the necessary dimensions, so no detailing of figures will be necessary. If a piece of metal of sufficient size is available, both the sides, back, and coping can be cut from a single sheet of 16- or 18-gauge brass or copper. Galvanised iron can be used at a pinch, and so can lead-coated steel, but the end of the hammer. The rounded corners of the copings of the tenders for " Jeanie Deans " and " Grosvenor " were done that way, and came out all right. They were in 20-gauge brass, which is far more liable to buckle and crack than the thicker metal specified for the " Minx." If you are using hard-rolled brass or copper, which makes lovely smooth and flat



Front of " Minx " tender

non-rusting metal is far more satisfactory. Plain steel could be used, as in full size, but it would need a thin sheet copper or brass lining, to eliminate the rust trouble. Apart from the deposit getting into pumps and injectors, and causing them to fail, rusty feedwater isn't exactly a good thing to put into a boiler. Mark out the sides on the strip, bend the corners over a piece of ½-in. steel rod held in vice and projecting from side of jaws, and bend the coping over by putting two long parallel pieces of steel bar between the vice jaws in place of the steel insets, and gripping the metal between them. The rounded corners of the coping need a little judicious wangling to get them finished off nicely, but this is another job which is easy when you know how. I usually bend a bit of bar to the required radius, then bevel it off in the bend, to the angle of the coping. The corner of the tank body is placed in the bend in the bar, and the edge that forms the coping is carefully hammered down on to the bevel, with the ball sides, anneal the corners only with a blowlamp. The part which doesn't need heating, can be placed in a pail of water; I've worked that wheeze dozens of times and found it worked fine. If you heated the whole lot to red, and quenched it in water, you would find the sheet metal looking like the waves of the Channel. The only bits that need softening, are the embryo corners of the coping. Galvanised iron, and lead-coated or plain steel, won't need softening at all, being sufficiently ductile to be hammered over to the round-corner shape without cracking.

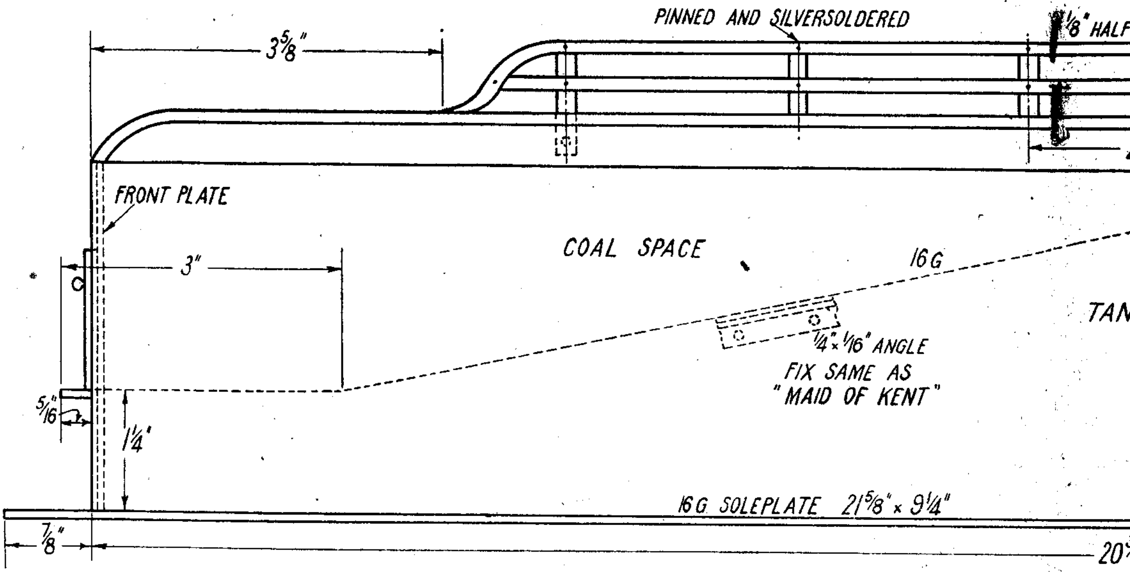
If a sheet of metal big enough for the whole body isn't available, use two pieces, each piece forming one side and half the back, instead of the three-piece construction of the straight-sided tender. The reason for this, is the rounded corners; it would be difficult to get nicely rounded corners with a joint in them. Bend as above, then butt the two halves of the back together, put a butt strip inside about ½ in.

wide, and fix it with $\frac{1}{16}$-in. rivets all the way down. When the tender body joints are sweated up, the butt is filled up with solder; and the application of a file, and a finishing rub with emery-cloth or similar abrasive, will render the joint invisible when the tender is painted.

Front End

The front end of the "Brighton" tender differs from the "L1" type inasmuch as the corners are rounded, and the front plate comes flush with the front end of the body, instead of being set back. First of all, bend the ends inwards over a bit of $\frac{3}{4}$-in. round rod in the vice jaws, so that the edges of the side sheets are $\frac{3}{4}$ in. from the side panels; see front view. Next, cut the front plate to a width of $7\frac{1}{2}$ in. and height of $3\frac{5}{8}$ in. Fit a coal-gate to it, as described last week; this is absolutely correct for the "Minx." Now put this across the front of the tender body, with the curved front ends overlapping $\frac{5}{16}$ in. each side. Put a toolmakers' cramp at top and bottom, and check off the distance between sides, at front and back; you don't want the body to look like a coffin, so see that the sides are parallel. When O.K., rivet the lap joints with either $\frac{1}{16}$-in. or 3/32-in. rivets, whichever you prefer.

The angles inside the body, for supporting the coal-plate and the removable top of the tender, can then be fitted, as described last week. If the body is a two-piece job, joined at the back, as above, the angles could be fitted to the sides, if desired, before assembly, same as the "Maid" tender; but with a one-piece body, it is advisable to fit the front plate first, to help support the body whilst attaching the angles. Here is another wheeze for beginners, which will save their time, cut out a lot of measuring and make certain the angles on each side are same height. Cut a bit of cardboard to the length of the tender side; and mark out on it the height and slope of the coal-plate, and the height of the removable top. Cut along the marked line; stand it inside the tender, against each side in turn, run your scriber along the top, and make a deep scratch on the metal. If your angles are riveted flush with the scribed line, both sides must necessarily be the same height and slope. You won't find that method advocated in any technical dissertation on marking out, but—it works!



Details of tender body for

Coal Rails

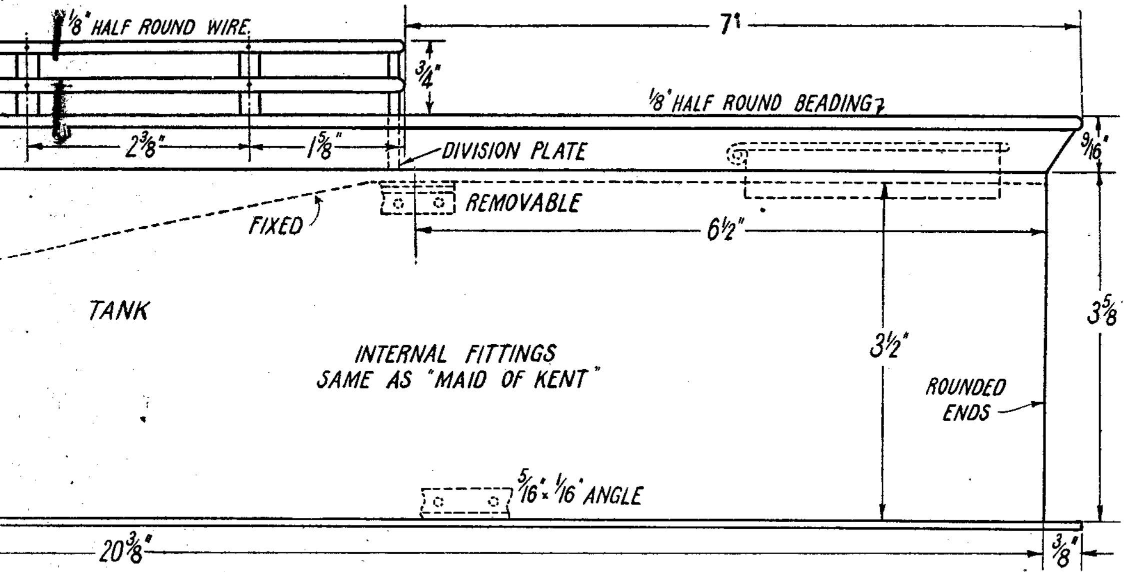
If the coal rails and beading are fixed to the tender body before same is attached to the soleplate, it makes easier work, as you don't have to perform evolutions with the chassis. As a matter of fact, the coal rails might be left out altogether, as they are not needed; if the coal were piled up between them, you couldn't get at the footplate fittings from a driving car behind the tender. When the "Vulcans" were new, they had no coal-rails at all; same were added after rebuilding. However, they give a sort of "finish" to the coping, and look rather business-like, so I have shown them in the drawing. The best stuff to make them from, would be half-round wire; nickel-bronze (German silver) for preference, as this is usually hard-drawn, and will take a certain amount of rough usage without becoming dilapidated. Coal rails knocked into all sorts of shapes, are no ornament to any tender; and in some full-size tenders, plate extensions have been substituted or else placed inside the rails as reinforcements.

When making the coal rails for "Jeanie Deans's" tender I did the whole lot in one long straight length. This ensured that when the corner bends were made, the top and bottom rails lined up all right. In the present case,

two 30-in. strips of the $\frac{1}{8}$-in. half-round wire would be needed, and a dozen supports $1\frac{1}{8}$ in. long, made from $\frac{3}{16}$-in. by $\frac{1}{16}$-in. strip. I made use of the weeny home-made toolmakers' cramps, mentioned in a previous note, to hold the bits together, and the silver-soldering was done with a small tip in the oxy-acetylene blowpipe, which heated the joints to red without heating the clips as well. If you only have an ordinary blowlamp, or air-gas blowpipe, it would be advisable to rivet the coal rails to the supports; bits of domestic pins would do well for rivets, as they only have to hold the bits together whilst the silver-soldering operation is in progress. Soft-soldering isn't much good, as one or two accidental bangs or clouts, would split the joints apart.

After attaching the rails to the supports, finish off the ends as shown, bending down the upper rail to beading level, and silver-soldering the lower rail to it. The assembly can then be bent to shape; the lower ends of the side supports are riveted to the coping, after bending to suit the angle of same. The lower ends of the back supports are riveted to a strip of metal, cut to size and shape shown, which forms the division plate on top of the tank.

There is no need to dilate on the beading. This is merely a length of the same kind of half-round strip used for the coal rails, and it is soldered all around the top of the coping, flush with the edge. The above-mentioned little cramps are mighty handy for this job; a few inches of the beading are clipped in place, soldered, and then the cramps are shifted along a few more inches, and process repeated until the whole length all around the tender, has been attached. A discarded or worn-out flat-file, with the end ground off square and the teeth ground away about $\frac{1}{4}$ in. from the end, makes a first-class scraper to remove any solder that may have oozed through below the beading. The solder should be quite invisible.



ender body for "Minx"

Erection and Fittings

The bottom of the coal-space, and the removable part of the tank top, with filler and hinged cover, are made and fitted as described last week, the only difference being that the plates must be cut to fit nicely in the rounded corners of the tender body. This is attached to the soleplate in the same manner as the straight-sided one. The installation of the pump is also the same. We left off at the point of fitting the water-valve, pipe, and strainer for injector feed. At the footplate end of the tender, mark off the position of the valve, as shown in the side and end views in last week's illustrations; and at this point, drill a $\frac{5}{16}$-in. clearing hole (letter "O" drill). Measure the distance on the fitting you have made up—valve, pipe, and strainer—between centre of valve and centre of strainer; and at this distance behind the centre of the hole just drilled, and in line with it, drill a $\frac{3}{8}$-in. clearing hole. Now put the assembly in place, with the top of the valve through the $\frac{5}{16}$-in. hole, and the gauze strainer through the $\frac{3}{8}$-in. hole, projecting into the tank. The valve is held in place by a $\frac{5}{16}$-in. lock-nut above the footplate; the strainer fitting is fixed to the underside of the soleplate, by three 8-B.A. brass screws, the holes in soleplate being tapped, and a 1/32-in. Hallite or similar jointing gasket being interposed between soleplate and flange.

The bracket supporting the upper part of the valve pin is bent up from a piece of 16-gauge steel, and attached to the front plate of the tender by a couple of 3/32-in. or 7-B.A. round-head screws, nutted at the back of the plate.

The head and cross-handle are fitted after the spindle has been pushed through the hole in the bracket; the handle should be 3/32-in. round steel, rustless preferred, pressed through a No. 43 hole drilled through the head, which should be silver-soldered to the spindle. Note: in the illustrations, the valve is shown on the left-hand side of the tender, and the brake column to the right (eh? oh no, no mistake at all; you are looking at the front end of the tender in the drawing, which puts the left-hand side of the tender on your right, and vice versa) and this position is correct for a left-hand drive engine; that is, one on which the driver stands on the left-hand side of the cab, same as we did on the old L.B. & S.C. Rly. The reversing wheel, brake valve, etc., are all on the left-hand side, in that case. However, if anybody has made the engine right-hand drive, the position of the water-valve and the brake column should be changed over, as the hand brake on all engines is always located on the fireman's side.

On the "Maid's" tender, the valve is well back from the front edge of the soleplate, owing to the tender front plate being located a short way behind the leading end of the side sheets; but on the "Minx," it must be placed more forward. Drill the $\frac{5}{16}$-in. clearing hole at the same distance from the centre-line of the tender, but only $\frac{1}{4}$ in. ahead of the front plate. This just gives enough room to tighten up the locking-nut and the gland nut. Of course, a combined valve and strainer could be made and fitted inside the tank, behind the front plate; but this would need either a gland where the spindle passes through the coal plate, or a tube reaching as high as the top of the front plate, with the spindle of the valve inside it, to prevent water coming out. Either arrangement forms an obstruction in the coal-space, which is a nuisance, as the engine has to be fired from the back of the tender, and the coal shovelled up the opposite way to full-size procedure. I've got two of them on "Grosvenor," same as big sister, and it is a good job she needs very little firing, because I keep on hitting them with the shovel.

Pump Feed and By-pass

The strainer and feed-pipe for the pump, is similar to that for the injector, and the strainer is fitted in the same manner, the location being level with the injector strainer, and approximately in line with the end of the feed-pipe projecting through the bracket on the engine drag-beam, The end of the pipe is bent down a little, and a piece of rubber tube slipped over it, long enough to allow the other end to be pushed over the before-mentioned feed-pipe when the engine is coupled up. On full-size engines, the feed-bags are joined by unions reminiscent of the N.F.S., but as there is no pressure to withstand on the pump and injector feed lines of a little engine, slip-on hoses save trouble. We have to use a union on the hand-pump connection, as the pressure of water generated by operation of the pump, would otherwise blow it off.

The by-pass fitting is made in a manner somewhat similar to the strainer fitting, but it need not be so large (see last week's illustration) and instead of a gauze finger, the upper end carries a length of 5/32-in. pipe. This is silver-soldered into the fitting at the same heat as the bottom pipe, and softened at the same time. Bend roughly to shape before inserting; then, after securing the flange to the underside of the soleplate, bend the pipe so that the upper end can be seen through the filling hole. A small brass clip can be made and fitted, to hold the pipe in position; it will do quite well if merely soldered both to the pipe and the tank side, and Inspector Meticulous can't see it when the removable part of the tank top is screwed down. The pipe under the soleplate is connected to the by-pass valve under the engine cab, by a similar length of rubber hose to that on the feed-pipe. If you can get different-coloured rubber tube, it simplifies coupling up, and prevents the hoses being attached to the wrong pipes on the engine. When I can get it, I use red for feed, white for by-pass, and grey or black for injector. The tube used for automobile screen wipers of the suction-operated type was all right at one time, but I found that the ribbed kind was very prone to split. Several times an injector has suddenly failed when the engine was running on my road, and the trouble has been the feedbag splitting and letting air be drawn in. In every case, a new hose has cured the trouble. It is imperative that injector water lines be absolutely airtight.

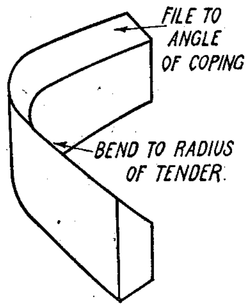
The above notes on internal fitments apply equally to "Maid of Kent" and "Minx"; and when they are all installed, all that remains is to screw down the removable part of the tank top. Incidentally, the hand-pump, feeds, by-pass, etc., will be practically the same for the L.M.S. tender; so builders of "Doris" should take heed, and that will save the necessity for a repetition of the whole rigmarole. At the present moment, I am getting out the general arrangement and chassis details of a standard L.M.S. tender for "Doris"; and these will appear, all being well, as soon as ready. As to the "Maid" and "Minx," there is only the brake gear, and a few trimmings to fit, and the job will be completed.

Gossip

Older followers of these notes bemoan the disappearance of the old friendly chinwags, items of personal news, and so on, that used to "put the jam around the pills," and complain that there is now too much of the "instruction" side of the business. Well, others prefer it, as they like to get on with the job as quickly as possible; but I might point out that six years of hell-upon-earth, plus four more of grief, misery, and austerity, hardly make one feel like cracking jokes, indulging in friendly banter, or doing a bit of harmless leg-pulling. However, I'd hate to be considered a "wet blanket," so circumstances and the K.B.P. permitting, we'll see if anything can be done about it.

Before long, you will be seeing announcements in the advertisement columns, about some "L.B.S.C." handbooks, and a new "Live Steam" book. Well, you'd be tickled to death to know how this came about. Our Advt. Manager is rapidly becoming a jolly fine engine-driver; in fact, he says he would rather handle regulator and brake, than go around selling advertising

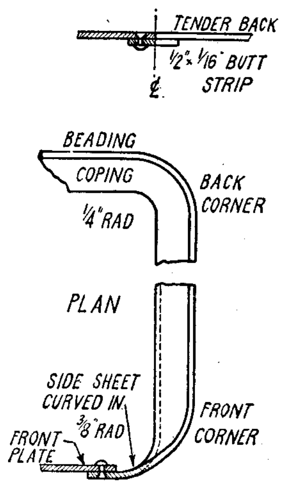
space. He also rides the flat car extremely well, and has never had a derailment; says his weight keeps it on the road! Anyway, on a recent afternoon, he brought along our Commercial Manager, to take him for a trip over my line; but owing to Jupiter Pluvius, the proceedings



Former for flanging coping bends

were a complete washout—literally!—and instead, we had a friendly confab over a cup of the engineman's best friend. We got talking about "Maisie," "Dairymaid," and some of my older "serial story" engines, and "Bro. Sales" said he often had inquiries for back numbers and blueprints, but could not supply, as Jerry had blown up the back numbers, and blueprints had not been made. He then suggested publishing some handbooks, each describing one of the older engines, also bringing out an up-to-date "Live Steam" book. I said O.K. by me, as long as it didn't involve me in any fresh writing and drawing; but I agreed to check the proofs, and so it was settled. "Bro. Adverts." said he would do his bit by seeing that the books contained the addresses of suppliers of parts needed for building; and as to blueprints, a week later I had the pleasure of taking "Bro. Sales" down to Ashford on the gasoline buggy, where he fixed up with Roy Donaldson for the necessary prints to go with the handbooks. Confidentially, "Bro. Sales," who is a motorist of no mean ability, got the shock of his life when I told him "Black Maria" was a 12 h.p. car over 12 years old. The way she flew over the Kentish hills on top gear, and maintained an effortless 50/52 on the level with hardly any throttle, completely deceived him about the power, and her personal appearance belies her age—but it bears out old Billy Stroudley's dictum of "one engine, one driver." She is "light on coal," too; less than 3½ gal. for the round trip of 110½ miles. My great sorrow is, that she lacks a boiler!

On Good Friday evening, I had the pleasure of seeing a magnificent piece of work. The original designer of a 5-in. gauge L.M.S. 2F dock shunting engine, Mr. L. T. Truett, the well-known builder of Sanderstead, brought his finished chassis along for comment. Regular followers of these notes may remember that an outline drawing, with details of the boiler, and some photographs of the job under way, were shown a considerable time ago. Mr. Truett has certainly combined full-size practice with a robust construction capable of standing up to continuous hard work, and has also incorporated the principles put forward in these notes. I tried her under air pressure, and she certainly goes as well as she looks. Mr. Truett is obtaining some close-up photographs for publication in due course; and when they appear, I hope to have something to say about her constructional details.



Back seam of tender, and plan of coping

"Fayette" Details Wanted

Mr. H. J. Higgins, 14, Albert Place, Pitville, Cheltenham, Glos., desires either to purchase or to borrow the issues of THE MODEL ENGINEER containing the "words and music" for "L.B.S.C.'s" 4-6-2 locomotive "Fayette." Mr. Higgins possesses the blueprints which were supplied with the set of castings, but they do not show steam inlet to the cylinders, arrangement of exhaust pipe fittings, position of guide-bar brackets and other details. If any reader can possibly help, would he please communicate with Mr. Higgins at the above address?

IN THE WORKSHOP

by "Duplex"

*38—Gear-cutting in the Lathe

IF a gear wheel is to work satisfactorily, it is, of course, essential that its bore should be formed concentrically in relation to the circle on which the teeth lie. The blank is, therefore, either turned and bored at one setting, or the bore is first machined and the outer diameter is then turned to size with the work mounted on a true-running mandrel supported between the lathe centres; alternatively, a stub mandrel, turned to size while gripped in the chuck, may be used for this purpose.

When a mandrel is used in this way, both the side faces of the work can be finished-turned to reduce the blank to the correct width. Where the diametral pitch system is used, it has already been seen that the number of teeth divided by the diametral pitch gives the diameter of the wheel measured on the pitch-line of the teeth; also, if the overall diameter is required, then two teeth are added and the total is again divided by the diametral pitch. Supposing, therefore, that a pinion of 32 D.P. having 30 teeth, has to be cut; the outside diameter of the blank will then be $\frac{30 + 2}{32}$, which equals 1 in.

When turning the blank to its finished diameter, it is important that an exact measurement should be made with a micrometer, for, as will be seen later, the teeth are cut to the correct depth and thickness by feeding the cutter inwards and using the outer diameter of the blank as a reference surface.

If the finished blank has to be removed from the chuck, it is essential for the gear-cutting operation that it should be remounted on a true-running arbor, supported either between the lathe centres or in the gear-cutting attachment as the case may be.

Cutter Speed

It is advisable to drive the cutter at approximately the correct speed, for if it runs too slowly the machining operation will be unnecessarily prolonged, and if too fast, the teeth are apt to become blunted.

As in ordinary turning, the cutting speed depends both on the material being machined and on the type of steel of which the tool is made. In milling operations, such as gear-cutting, it is the common practice, in the case of steel at any rate, to use a cutting speed of some two-thirds that employed when turning.

The following Table shows the linear feet per minute at the outer diameter of the cutter appropriate for different materials; this refers to a carbon-steel gear-cutter, but these speeds can be safely doubled when a high-speed steel cutter is used.

Material	Peripheral speed of cutter ft. per minute
Carbon-steel ..	25-30
Mild-steel ..	30-40
Cast-iron ..	40-50
Bronze ..	60-80
Brass	90-100
Aluminium ..	200-300

The following are the approximate peripheral speeds for cutters of various diameters.

Revs. per min.	Diameter of Cutter	Speed ft. per min.
100	1 in.	25
100	$1\frac{1}{4}$,,	30
100	$1\frac{1}{2}$,,	37
100	$1\frac{3}{4}$,,	44
100	2 ,,	50

To obtain the revolutions per minute the cutter should run, multiply the figure 100 in the first column by the peripheral speed required, and divide the product by the figure shown in the third column; thus, supposing a 1 in. diameter cutter is to be given a peripheral speed of 50 ft. per min. for machining a cast-iron pinion: then $\frac{100 \times 50}{25} = 200$ r.p.m.

This example may also be worked out quite simply by dividing the peripheral speed required by the approximate circumference of the cutter expressed in feet: $50 \div \frac{3}{12} = 50 \times \frac{12}{3} = 200$ r.p.m.

It will not, of course, be possible in many cases to drive the cutter at exactly the calculated speed, but this is immaterial, as the cutting speeds given can be only approximate and vary over a fairly wide range; it is important, however, to run the cutter too slowly rather than at an excessive speed in order to preserve the sharpness of its teeth.

Centring the Cutter

After the cutter and the gear blank have been mounted in the lathe, and the rigidity of the assembly has been enhanced by employing, whenever possible, the tailstock centre and the supporting centre fitted to the overarm of the attachment, the next step is to align the cutter and the gear blank so that the teeth will be machined in a truly radial direction. If this adjustment is not correctly made, the teeth will

*Continued from page 617, "M.E.," May 19, 1949.

in some degree have the form of ratchet teeth; Fig. 1 illustrates diagrammatically the appearance of the teeth resulting from faulty centring.

Care is taken in the manufacture of commercial gear-cutters to ensure that the teeth are formed equidistant from the two side faces of the cutter; this allows measurements to be taken from these two surfaces when setting the cutter exactly on the cross centre-line of the work.

Fig. 2 illustrates one method of locating the cutter by means of a try-square resting on the lathe cross-slide, and applied in turn to either side of the work. The distances A and B between the sides of the cutter and the edge of the square can then be checked for equality, either with the aid of the inside calipers or by employing a micrometer.

When the cutter is mounted vertically, as in Fig. 3, it can be set with reference to the lathe centre height (A) by setting the lower face of the cutter below this height by an amount equal to half the thickness (B) of the cutter. Needless to say, these measurements must be made with greater accuracy than can be obtained by merely using a rule for the purpose; instead, the thickness of the cutter is measured with the micrometer and the distance (C) is then correctly adjusted with the aid of the inside callipers set from the micrometer.

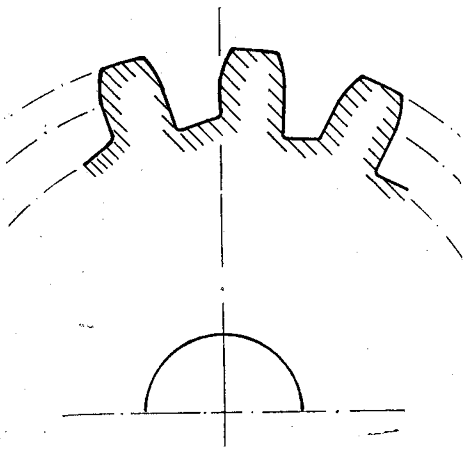


Fig. 1. Showing teeth cut off-centre

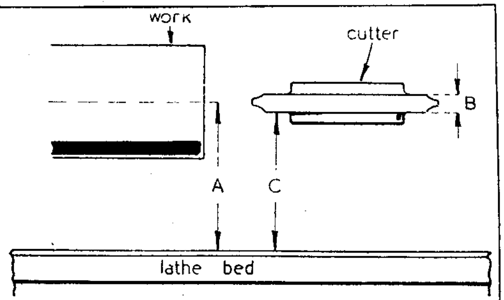


Fig. 3. Centring cutter from lathe bed

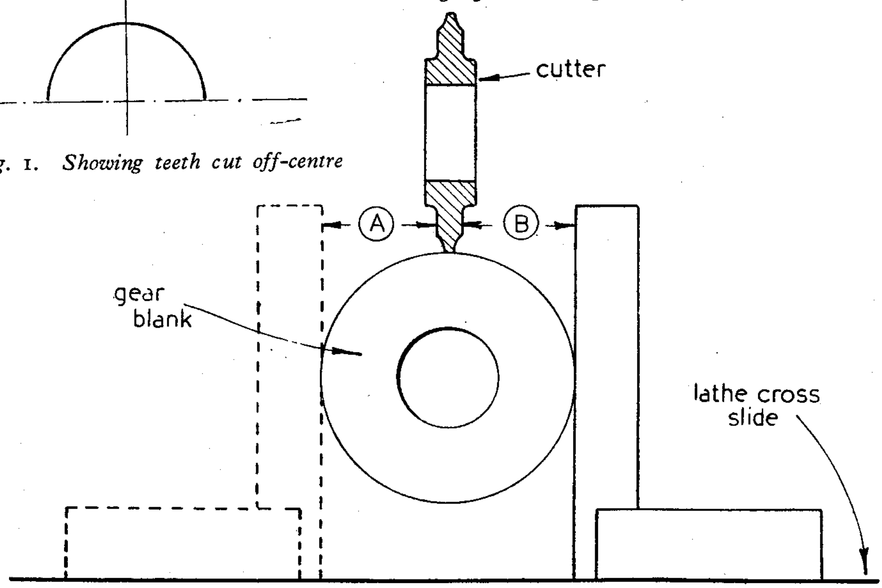


Fig. 2. Centring cutters with a try-square

An alternative method is to turn a piece of rod held in the chuck to a diameter equal to the thickness of the cutter, next, as represented in Fig. 4, the dial test indicator is applied to the rod and a reading is taken; the cutter is then raised until the indicator in contact with its upper surface records a similar reading. Should it not be found possible to apply the contact point of the indicator directly to the cutter in this way, the reverse attachment, designed for application to bored holes, is fitted to the indicator and its ball-ended lever is then brought in turn into contact with the *lower* surface of the rod and the cutter.

Much trouble may be saved if a small adjustable

gauge of the form shown in Fig. 5 is employed to set the cutter.

This gauge stands on the lathe bed or cross-slide, and the V-notch, after being set to centre height against the tailstock centre, is offered to the cutter, which is then adjusted until both limbs of the V make even contact with the tips of the teeth.

An alternative form of setting gauge is that

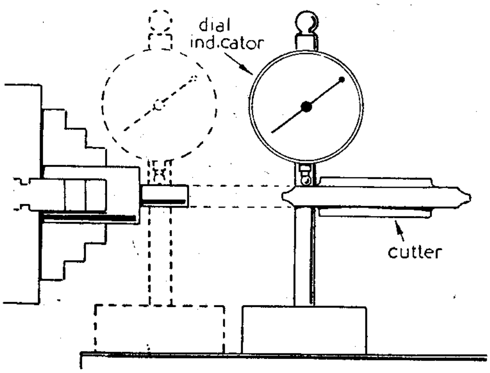


Fig. 4. Centring cutter with test indicator

depicted in Fig. 6, which is designed for fitting to the scriber clamp of the surface gauge; this allows the fine adjustment of the gauge to be used to facilitate the initial setting operation.

One disadvantage of this type of device is that it may be found rather difficult to determine the exact setting of cutters of very small pitch; but this will be largely overcome if in this case a V of very shallow form is used.

One method of checking the setting of a vertically-mounted cutter is to bring it into contact

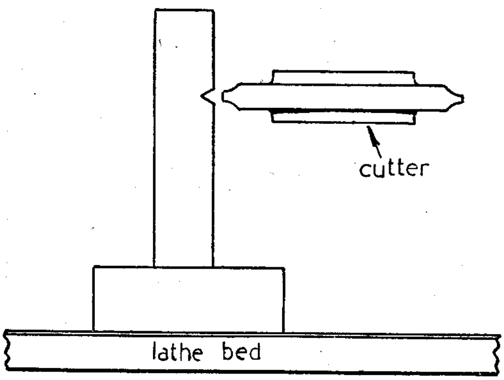


Fig. 5. Using V-gauge for centring cutter

with a centre-line scribed on the work by means of a V-tool mounted on its side at centre height; the cutter is then turned by hand until, as shown in Fig. 7, it just cuts the edge of the work; examination with a lens should then reveal any error of setting requiring correction.

This method can also be applied when the gear blank is mounted in a gear-cutting attachment, but in this case a cross centre-line should be scribed on the blank at the time of the turning operation. This cross line is set vertically by means of a square, and the adjustment of the cutter, mounted between the lathe centres, is checked, as in the previous instance, by an examination of the impression made by the cutter teeth.

Rate of Feed and Depth of Cut

Now that the speed of the cutter has been set and its correct alignment with the work adjusted, it remains to determine the rate of feed and the depth of cut in order to carry out the actual machining of the gear teeth.

The feed recommended by Messrs. Brown and Sharpe for a high-speed steel cutter of 12 D.P., when machining the gear teeth to full depth at a single passage, represents a cut of approximately 2 thousandths of an inch per tooth, or a total of some 30 thousandths for each revolution of the cutter. These figures apply to a commercial type of milling-machine of great rigidity specially designed for this work. This performance should not, however, be expected of a small lathe, and the amount of metal removed in a given time must be correspondingly reduced.

In ordinary turning operations, where the

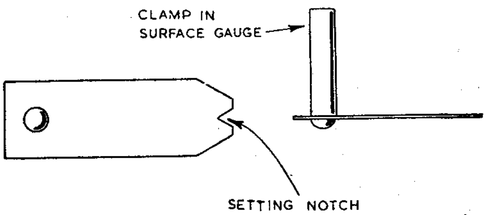


Fig. 6. V-gauge for fitting to surface gauge

rate of feed is perhaps 200 turns of the mandrel for each inch of traverse, the depth of cut might be, say, 60 thousandths of an inch for roughing and may be 5 thousandths for finishing the work.

In this instance the conditions are favourable for the rapid removal of metal, for the tool is provided with suitable rake and the cut is continuous; the gear-cutter, on the other hand, cuts simultaneously on three faces which have little or no rake, and in addition, the cutting action of the teeth is intermittent.

If, when gear-cutting, the rate of feed mentioned, and representing a cut of 5 thousandths of an inch per revolution of the cutter, is retained, it may be found that the depth of cut has to be reduced to obtain satisfactory machining, but this will depend largely on the rigidity of both the milling attachment and the lathe itself.

This cut of 5 thousandths of an inch per revolution represents half a thousandth per tooth where the cutter has ten teeth; this should ensure that every tooth shares in the cutting operation, and that some do not become blunted by merely rubbing against the work, for it is almost inevitable that the cutter, when mounted, will not run with absolute truth. Should the cutter run markedly out-of-tooth, the brunt of the work will fall on a few teeth only and the gear-cutting operation, besides being slowed in proportion, will be more akin to fly-cutting.

The depth to which the tooth must be cut, termed in gear-cutting parlance the Whole Depth of Tooth, is given in the following Table for the more commonly used diametral pitches.

Diametral Pitch	Whole Depth of Tooth
10	0.2157 in.
12	0.1798 ,,
14	0.1541 ,,
16	0.1348 ,,
18	0.1198 ,,
20	0.1079 ,,
22	0.0980 ,,
24	0.0898 ,,
26	0.0829 ,,
28	0.0770 ,,
30	0.0719 ,,
32	0.0674 ,,
34	0.0634 ,,
36	0.0599 ,,
38	0.0568 ,,
40	0.0539 ,,

Should the tooth depth of other pitches be required, this information will be found in any standard reference book dealing with the subject.

To determine the depth of cut allowable, it is advisable, in the first instance, to take a trial cut using a hand-feed as nearly as possible equal to the power feed to be employed ; the feel of the cut, the noise produced, and any resulting vibration or chatter will then serve to indicate to the operator when the maximum allowable depth of cut has been reached.

Needless to say, the lathe slides should be correctly adjusted to eliminate shake, and it is advisable to set the cross-slide gib to give rather stiff working ; in addition, in order to maintain rigidity, any slide that is not in actual operation should be firmly locked.

If, after taking these precautions, there is any tendency for chatter to develop, it may be found advisable to reduce the speed at which the cutter is driven.

To ensure that each tooth is cut to the correct depth, the cutter is brought into contact with the gear blank, and the index of the cross-slide or vertical-slide, as the case may be, is set to the zero mark and locked in that position.

From time to time during the machining operation the adjustment of the supporting centres should be checked so that any slackness that may have developed can be taken up.

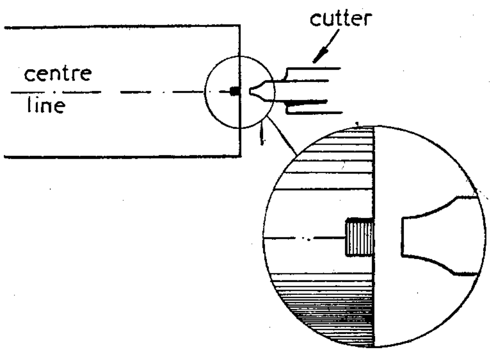
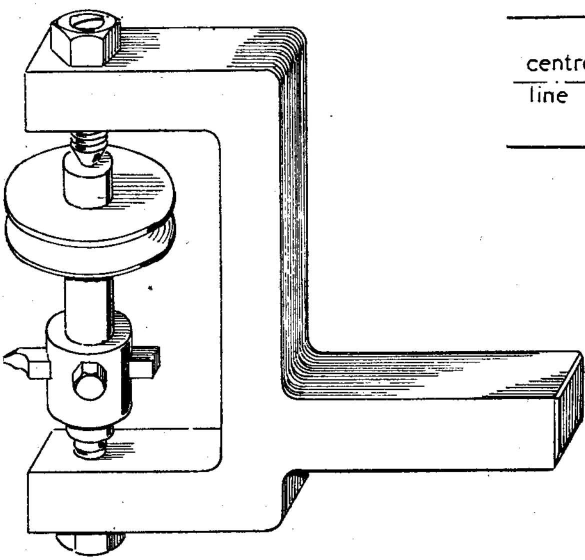


Fig. 7. *Checking the setting of the cutter*



Left.—Fig. 8. *Fly-cutter mounted in cutter frame*

The advantage gained by cutting each tooth to the full depth at a single passage of the cutter is chiefly that of time and trouble saved, for the teeth have then to be indexed once only.

On the other hand, when two or more cuts are used and a light finishing cut is taken over each tooth in succession, both the mechanism and the work are subjected to less stress and the accuracy of the teeth will in consequence be enhanced ; furthermore, the finishing cut will remove any inaccuracy resulting from distortion due to local heating during the machining operation, and any wear of the tool's cutting edges will be more equally distributed over all the teeth.

Fly-Cutting Gear Wheels

To save the expense of buying the appropriate circular gear-cutters, some workers use fly-cutters for machining toothed wheels. Although this operation might be found intolerably slow for cutting large or coarse-pitch gears in steel or cast-iron, it is quite satisfactory for machining brass or duralumin wheels of moderate or fine pitch, particularly where the tooth face is narrow.

In the case of the latter materials, the cutter can be run at high speed, and the speed can be correspondingly increased as the radius of the cutter is reduced ; this will allow a rate of feed to be employed that will be found sufficiently rapid to give satisfactory working.

The cutters can be conveniently made of silver-steel and, after they have been filed to shape by using a gear wheel as a template, the cutting edges must be backed off to form the necessary clearances. If, following the hardening and tempering processes, these tools are carefully honed with an oilstone slip, a very high finish will be imparted to the surface of the teeth cut.

Cutters of this form can be readily mounted

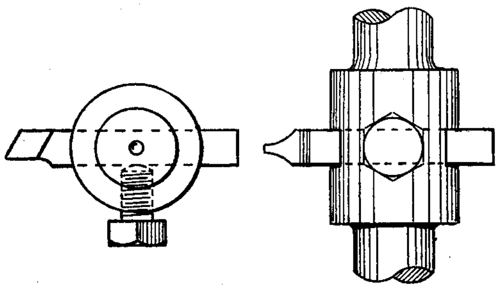


Fig. 9. Fly-cutter secured in spindle of cutter frame

and operated in a cutter frame of the type illustrated in Fig. 8. The projecting lug on the frame is secured in the lathe toolpost, and the spindle, which is driven from the overhead, runs on two adjustable, coned bearing-screws.

As shown in Fig. 9, the enlarged portion of the spindle is cross-drilled and then filed to provide a seating for the cutter, which is secured in place by means of a set-screw.

The cutter can be set to the centre height of the work by using packing strips in the toolpost, but it may be found easier to make the final setting by adjusting the pivot-screws to raise or lower the cutter for an exact distance.

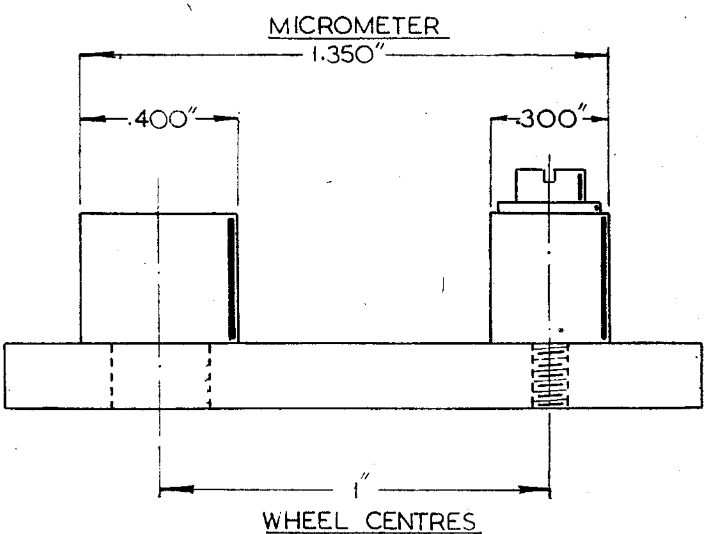


Fig. 10. Setting gear centres with a toolmaker's button

It may be mentioned that single-pointed cutters of this type can be used to plane or shape gear wheels in the lathe.

For this purpose, the cutter is mounted on its side at centre height in the toolpost. The gear blank is held in the chuck or is mounted on an arbor supported between the lathe centres, and the teeth are indexed either by using a mandrel dividing-head or by means of a change wheel secured to the tail of the mandrel. The tool, which is fed inwards by operating the cross-slide, is moved across the face of the blank either by traversing the saddle or, if preferred, the top-slide feedscrew can be removed to allow this slide to be worked to and fro by means of a hand-lever pivoted to the lathe bed or to the cross-slide.

When machining bronze gears in this way, it is advisable to withdraw the tool from the work on the return stroke, otherwise it may be found that the clearance at the cutting edges is soon worn away.

Meshing Gear Wheels

Before leaving this subject, it may be opportune to describe briefly the methods commonly employed in small machine shops for locating gear wheels to mesh and run correctly. In large concerns this work would, of course, be carried out with the aid of suitable jigs.

Gears cut on the diametral pitch system should be meshed so that the pitch circles of the teeth are in contact.

As previously explained, the diameter of the pitch circle is equal to the number of teeth on the wheel divided by the diametral pitch; the distance between the wheel centres is obtained, therefore, by adding together the radii of the pitch circles of the two wheels.

When setting out the position of the two whee shaft bearings, it is advisable to mark-out and machine one bearing and then to locate the second from this; in this way any error arising in the boring of the first bearing will be eliminated at the subsequent setting to locate the second shaft bearing.

Where it is required to locate a pinion to mesh with a wheel whose shaft bearing has already been machined, the following procedure, illustrated in Fig. 10, may be adopted.

Here, the two 32-tooth gears of 32 D.P., taken as an example, have a pitch circle 1 in. in diameter, and their working centres will therefore lie exactly 1 in. apart.

A spigot is turned to fit the bored bearing accurately, and its head is made to an exact diameter of, say, 0.400 in.

(*Continued on page* 683)

The Measurement of Efficiency in Small Gauge Locomotives

by C. H. Roberts (Buenos Aires)

IN the most interesting article on "Locomotive Testing at Sunderland," published in THE MODEL ENGINEER on November 11th, 1948, results of tests made with eight locomotives of $2\frac{1}{2}$-in., $3\frac{1}{2}$-in. and 5-in. gauges were tabulated, as arrived at by applying the formula :

$$\frac{\text{No. of laps} \times \text{load in lb.}}{\text{Theoretical T.E.} \times \text{fuel oz.}}$$

and also the same without the factor "fuel."

The formula as given seems too comprehensive, since the inclusion of "Theoretical T.E." gives weight to points of design and type of locomotive, and thus, for instance, would probably invalidate comparisons between cargo and passenger engines.

The chief object of a full-size locomotive is to haul a suitable load at a reasonable speed for a certain distance on as little fuel as possible.

To measure this efficiency in one single formula is rather a tall order, but it would seem that, *provided the load is suited to each engine* :

$$\frac{\text{Actual distance} \times \text{Load} \times \text{Ratio of distance}}{\text{Basic distance} \times \text{Fuel} \times \text{Time}}$$

would be as good a method of calculation as any

In order to allow tests made on different tracks to be comparable, certain fixed rules should be laid down, of which some are suggested below :—

1. Distance

Basic : This should be a fixed amount proportionate to the linear scale of the gauge, say :

5-in. gauge	.. ..	2,000 yds.
$3\frac{1}{2}$-in. ,,	.. ..	1,400 ,,
$2\frac{1}{2}$-in. ,,	.. ..	1,000 ,,

which would allow several minutes' running.

Actual : The actual distance of the test run should approximate the basic figure.

The track should preferably be continuous and "easy," i.e., with curves of a radius sufficient to avoid recourse to the brakes, and without severe gradients.

If it be impossible to arrange for a continuous run, tests may be made "up and down" a number of times proportionate to the gauge. The results from this class of test cannot well be compared with those produced on an endless track, but by the inclusion of a constant, depending on the length of each trip, some approximation may be obtained. This constant would have to be arrived at by careful experiment with the same locomotive with the same driver under similar conditions, on the different tracks.

A good warming-up run should be allowed immediately before commencing the test. Starting should invariably be on a level stretch of line.

2. Load

The load as computed should include the "live" weight of engine and tender, trucks, driver, and load proper. This latter would be made up as far as possible with passengers, the final make-weight being preferably a can or cans of water, to avoid the dead inertia of plain weights at starting and at changes in speed while running.

The total load should be proportionate to the weight on driving and coupled wheels of the locomotive, and should not involve flogging the engine ; say 15 times the adhesive weight.

3. Sand

No artificial aids to adhesion such as sanding or chalking the rails should be allowed, either at starting or during the run.

4. Ratio of Distance

This is expressed as "actual" divided by "basic." That is, if double the basic run is covered, the figure would be 2. The inclusion of this factor gives effect to the square of the distance, necessary because the cylinder volume/distance varies in this proportion, in accordance with the linear scale.

5. Fuel

Since the test as proposed measures only the running efficiency of the engine, without taking into account steam-raising and standing losses, the amount of fuel consumed during the test (from the moment the starting signal is given until the set distance has been covered) must be established with care, greater accuracy being required for the smaller locomotives.

It is the amount *consumed* during the run that must be used for the calculations, *not* the amount taken out of the tender.

It is suggested that careful note be taken of the depth (or height) of fuel in the box on starting, the fire being made up exactly to this level immediately upon completing the run, having carefully weighed the coal in tender or other container beforehand. In the case of liquid fuel, the tank could be filled to overflow level on starting, and again on completion, the amount thus added being measured.

It is further suggested that to facilitate the use of different qualities of coal, charcoal, oil, and other fuels, the factor should be established in calories, which would allow of comparisons being made between engines using different firing systems.

6. Trucks

The use of ball- or roller-bearings should not be prohibited, but it would be necessary to run different sets of tests with one and the other class. It is well to bear in mind that a truck may be very free-running without load, but may become difficult to haul with passengers, owing to friction between wheel bosses and axleboxes, binding in journals, and other reasons caused by flexing of frames, etc., under excessive strain.

1	2	3	4	5	6	7
1—3½—2-10-0	5	5	1,725—1	12.5—8	288—5	20.2—2
2—2½—2-8-0	2	7	1,093—3	12.6—7	252—7	21.9—1
3—2½—4-6-2	4	4	406—8	28.3—2	311—4	4.5—8
4—5 —0-6-0	8	3	1,120—2	18.6—5	484—3	7.2—5
5—3½—4-4-2	6	6	787—6	16.3—6	277—6	6.8—6
6—2½—4-4-2	1	2	790—5	29.6—1	592—2	16.8—3
7—3½—4-4-0	3	1	919—4	22.3—3	602—1	12.6—4
8—2½—2-6-2	7	8	462—7	22.2—4	222—8	4.6—7

To revert to the Sunderland tests: the table above shows results of different comparisons based on the figures given in the article, allowance having been made for an apparent misprint whereby the boiler pressure of Mr. Swaine's 4-4-0 is given as 60 lb., when it would seem to be 80 lb.

Headings of columns:

1. Number as in original table, gauge, wheel arrangement.
2. Order of merit per original formula with fuel factor.
3. Order of merit per original formula without fuel factor.
4. Result of formula $\frac{\text{Distance} \times \text{Load}}{\text{Fuel} \times \text{Time}}$ and order of merit.
5. Result of formula $\frac{\text{Load}}{\text{T.E.}}$ (T.E. at 100 %).
6. Result of formula $\frac{\text{Distance} \times \text{Load}}{\text{T.E. (at 100 \%)}}$ and order of merit.
7. Result of formula: $\frac{\text{Actual distance} \times \text{Load} \times \text{Ratio of distance}}{\text{Fuel} \times \text{Time} \times \text{Basic distance}}$

Column No. 6 has been calculated on the system adopted for the South London trials as reported on page 224, THE MODEL ENGINEER, of September 5th, 1946, but the figures are not directly comparable with those given in that article as the S.L. trials were made on an "up and down" track. Column No. 7 is calculated per formula proposed above.

It should be borne in mind that the "Theoretical T.E." is not a good factor to include, even when reduced to 70 per cent. of boiler pressure, chiefly because the T.E. to Adhesive Weight

0-6-0 HYPOTHETICAL TANK LOCOMOTIVE:

1—Gauge (for ease of calculation prototype is taken as 5-ft. gauge)	5 ft.	5 in.	2½ in.
2—Scale—linear	1	12	24
basic distance	24	2	1
3—Square	1	144	576
4—Cube	1	1,728	13,824
5—Scale weight (i.e., theoretical weight for 5 in. and 2½ in.)	134,400 lb.	77.7	9.72
6—Theoretical Load—Weight × 15	2,016,000 lb.	1166.6	145.83
7—Weight adjustment, based on frame thickness			
8— Frame thickness—actual	1¼ in.	0.15625 in.	0.09375 in.
9— scale	1¼ in.	0.10416 in.	0.05208 in.
10— ratio	1 : 1	1 : 1.5	1 : 1.8
11—Adjusted weight (line 5 × line 10)	134,400 lb.	116.6	17.5
12—Actual or probable load (line 11 × 15)	2,016,000 lb.	1,750	262.5
13—Cylinder bore (2)	18 in.	1½ in.	¾ in.
14—Stroke	24 in.	2 in.	1 in.
15—Driving wheel diameter	5 ft.	5 in.	2½ in.
16—Boiler pressure	220 lb.	100	80
17—Theoretical Tractive effort at 100% boiler pressure	28,512 lb.	90	18
18— „ „ „ 70% „ „	19958.4	63	12.6
Cylinder volume:			
19— actual per stroke	6107.27	3.53	0.442
20— relative per stroke	13,824	8	1
21— relative per distance	576	4	1
22—Grate area—relative (equals fuel consumption on time basis)	576	4	1
23—$\frac{\text{Theoretical Load}}{\text{Fuel}}$ per unit of distance (unit equal in all three sizes)	3,500	291.6	145.83
24—$\frac{\text{Actual Load}}{\text{Fuel}}$ per unit of distance (unit equal in all three sizes)	3,500	437.5	262.5

ratio is so large on models that the full T.E. cannot be utilised in the ordinary way. Compare, for example, two engines, one having double the Tractive Effort of the other. Hauling an equal load, in all probability the fuel consumption of each would be practically the same, but the result of the formula including this factor would indicate one as being twice as good as the other. Furthermore, area of piston rod and friction losses are ignored, both of which become increasingly important as the size of the machine diminishes. In a full-size locomotive the ratio of T.E. to Adhesive weight is usually kept about 1 : 3½ or 1 : 4 and a high proportion of the boiler pressure is available in the steam-chest. In small models, on the other hand, with the large cylinders commonly used, the T.E./A.W. ratio is vastly different. Slipping under heavy load is avoided by careful starting and sand, but advantages in economy and speed are obtained by linking up. Even so, it is doubtful if high pressure is maintained in the steam-chest, except at low speeds. Note the wonderful showing of the "Rainhill" locomotive at the South London trials, where it would seem that practically the full "Theoretical T.E." was "gainfully employed."

In the following table the percentage of steam-chest pressure exerted on the piston is shown for different cut-offs :

Cut-off at	75% stroke, mean effective pressure	90
" "	67% " " " "	80
" "	50% " " " "	69
" "	33% " " " "	50
" "	25% " " " "	40

(Source of information—*Molesworth's Engineering Pocket-book.*)

It will be seen that for one-third of the steam consumption, nearly half of the power is available.

A table showing calculations for three hypothetical engines is reproduced on the previous page.

From the foregoing figures, which it will be seen should give equal results for the three engines, columns as in Table I are tabulated below :

	Gauge	4	5	6	7
A. Based on Theoretical load (line 6)	5 ft.	350	70.7	1,698	14.6
	5 in.	29.2	13	25.9	14.6
	2½ in.	14.6	8.1	8.1	14.6
B. Based on Actual or probable load (line 12) without taking into account any probable increase in fuel consumption	5 ft.	350	70.7	1,698	14.6
	5 in.	43.8	19.4	39	21.9
	2½ in.	26.3	14.6	14.6	26.3

In the Workshop

(*Continued from page* 680)

A standard toolmaker's button, or one made for the purpose, having a diameter of 0.300 in. is then attached to the work face with its centre at a distance of 1 in. from the spigot centre, that is to say as nearly as this can be measured with a rule.

To locate the button accurately, its position is determined by applying the micrometer over both it and the spigot, as indicated in the drawing ; when the position of the button has been adjusted in this way, the central clamping-screw is tightened to secure the button firmly in place.

The micrometer reading required is equal to the 1 in. centre distance between the gears, plus half the diameters of both the spigot and the button which is $\frac{0.400}{2} + \frac{0.300}{2} = 0.350$ in., thus giving a total distance of 1.350 in.

Finally, when the work has been set-up in the lathe so that the button is located on the lathe centre-line, the bearing for the second gear wheel shaft can be bored with the assurance that it will be correctly positioned. Where the work is bolted to the boring table, it is located by applying the test indicator, while secured to the lathe mandrel, to the button and then turning the mandrel slowly by hand ; but if the work is held in the chuck, the test indicator is then used to set the button to run truly.

Should there be any difficulty in locating the gear centres by the above methods, the following alternative procedure for ensuring the correct meshing of the wheels may be adopted.

One wheel bearing is bored and a pivot is fitted to it to carry the wheel ; next, a second short pivot, akin to a toolmaker's button, is made to fit the second wheel. The latter pivot is lightly secured to the work face by means of its clamping-screw, and its position is adjusted until the wheels appear to mesh correctly and are found to run smoothly together with but little backlash. The second bearing can then be bored, as in the previous example, by using the button as a guide when setting-up the work in the lathe.

(To be continued.)

A Small Single-Cylinder Engine

by R. Johnston

HAVING acquired an old book on models published nearly half a century ago, I decided to try my hand at making a small single-cylinder horizontal engine, $\frac{5}{8}$ in. bore by $\frac{7}{8}$ in. stroke, which was given as an outline drawing. The information given was only of a general nature, and left much to the builder's ingenuity. Hence, I have the feeling that this little engine is a combination of the ancient and modern.

For instance, the turned pillars should be $1\frac{1}{2}$ in. high, but I reduced them to 1 in., and the diameter of flywheel was reduced by $\frac{3}{4}$ in. As no detail of crosshead and guide-rails was given, I finally made the modern type of crosshead slippers, as used in certain types of horizontal pumps—the shoe or heel of the crosshead moving along grooves in the slippers, which are in turn bolted to the soleplate.

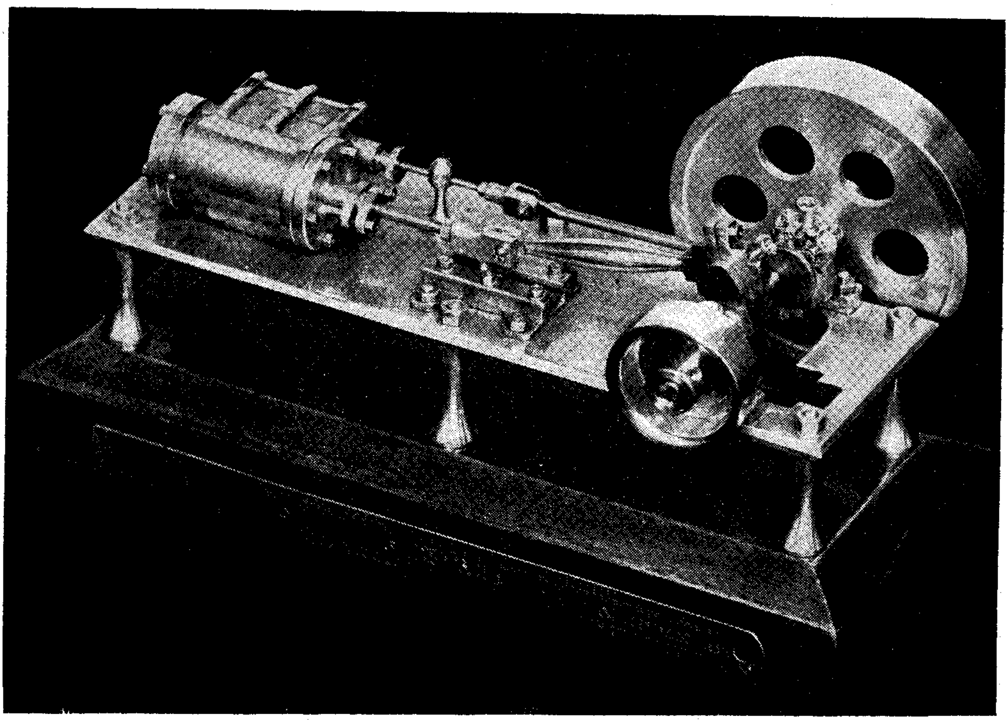
The crank is of stainless-steel, and was complete in itself. The method adopted might be of interest. I chucked and faced a piece of metal, centred it lightly, then removed it from the lathe, and carefully punched the distance of throw required from centre. This was next drilled and tapped to correspond with 4-B.A. studs let into the shaft. The metal was again chucked and carefully brought to centre, groove made to requirements, and width checked, and finally parted off. The result was not unlike a miniature fishing-reel. I carefully cut out a section, including the tapped portion, and the hub of the "reel." The result was a neat little one-piece crank, which was screwed on to the studded ends of the shaft, and a spot of solder put on.

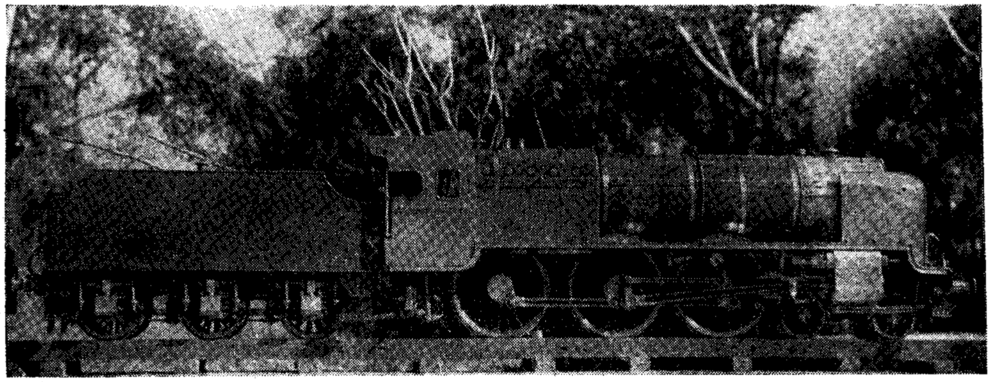
The connecting-rod is made of phosphor bronze, and was turned in one piece, being carefully cut away in the 4-jaw chuck to fit the crank, afterwards being halved and carefully fitted together in the usual manner, 10-B.A. screws and nuts being used for the purpose.

The eccentric straps were made in the same manner, the only difference being that provision was made for the rod to screw in. Lubrication to the journals and split bearings is provided by tiny oil-cups threaded 6 B.A., and bell-mouthed at the top, special care being exercised on the one for the crank, as this rides between the forks of the latter.

The piston is of stainless-steel and packed in the usual manner. The piston gland is of the plain oval type, fitted with studs, but the valve gland is screwed with a knurled edge.

The valve-rod is supported by a small pillar, but this is more for appearance than necessity. The exhaust steam is led through the soleplate by a $\frac{1}{8}$-in. bore copper pipe, which is supported by a stanchion fitted to the underside of the soleplate. A balancing strap was finally fitted to the flywheel.





A $\frac{3}{4}$-in. Scale 4-6-0 Locomotive

by H. G. Horn (Nigeria)

HEREWITH a short description of a locomotive which I started in Nigeria, West Africa during the war, and have now completed to steam trials stage.

The locomotive was originally intended to be a "Royal Scot," but as work progressed, deviation from the drawings took place, and I incorporated various other details which appealed to me.

All the castings, with the exception of the wheels were produced locally.

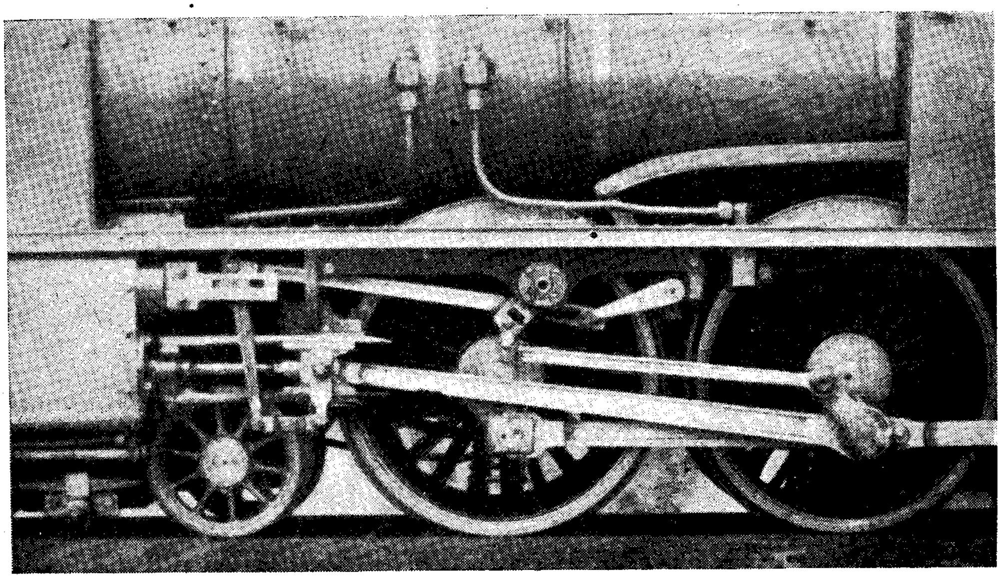
The boiler contains fifteen 7/16 in. diameter fire-tubes, and two $\frac{3}{4}$-in. tubes housing superheater elements, it was tested to 260 lb. per sq. in. hydraulic, and 120 in steam; the normal working pressure is 100.

Two cylinders $1\frac{3}{16}$ in. bore by $1\frac{3}{4}$ in stroke, are fitted with piston-valves of drawn bronze, working in cast-bronze liners, which were lapped, and the bobbins lapped to fit these.

Ball-bearings are fitted to connecting- and eccentric-rod big-ends. Two injectors, high and low pressure, and an axle-driven pump take care of boiler feedwater.

Cylinder drains are operated from the cab by a fine Bowden control, to a cross-shaft in front of cylinders, bogie and tender wheels are supported on working leaf-springs.

The locomotive weighs approximately 80 lb. without tender, and starts six adults without any difficulty, the maximum which present passenger cars will accommodate.



A close-up of the valve-gear

PRACTICAL LETTERS

Tests on Petrol Engines

DEAR SIR,—I should like to thank Mr. Dalziel for pointing out the error in my calculations of the cylinder pressures required to elongate the cylinder studs. He goes on to show that thermal-expansion could provide an answer.

I do not agree with this, since the identical studs, cylinder and cylinder-head had been used on a previous design (MODEL ENGINEER, October 16th, 1947, p. 438) with satisfactory results. Neither can I admit that the studs attain anything like so high a temperature as the cylinder. If expansion is the cause, leakage would be proportional to the cylinder temperature. This was not the case, leakage occurring immediately on starting up the cold engine. Also, no leakage could be detected immediately after stopping the hot engine.

The only difference, apart from crankcase improvements, in the new design is an increase in the compression ratio from 6.5 : 1 to 14.4 : 1. This would result in a decrease in cylinder temperature together with an increase in the explosion pressure.

Figures for explosion pressures at different compression ratios are given by Ricardo, *The High Speed Internal Combustion Engine* :—

Compression Ratio	Max. Cylinder Pressure lb. per sq. in.
4	300
5	490
6	650
7	800
8	950
9	1,090

Pressures for higher values of compression ratios are not given.

It will be seen that, from Mr. Dalziel's calculation, the dural studs would be sufficient to take care of the cylinder pressures developed with a compression ratio of 6.5.

The pressures increase at a higher rate than the compression ratio, so that the pressure developed with a compression ratio of 14.4 would certainly elongate the studs and allow leakage. Obviously, the better physical properties of the nickel-steel studs have cured the trouble.

In conclusion, Mr. Dalziel states that 3 per cent. nickel-steel has an even lower coefficient of thermal expansion than cast-iron. From figures I have been able to find, the reverse appears to be the case, nickel-steel expanding slightly more than cast-iron.

Yours faithfully,
Runcorn. R. E. MITCHELL.

Power Tools from R.A.F. Motors

DEAR SIR,—I was very interested in Mr. Law's article on the above, especially the hand-drill suggestion. I recently obtained one of the Cowling Gill motors concerned with a view to making a like conversion, and on stripping down the motor found that it should be easily possible to provide two alternative speeds by using either one or two of the epicyclic trains.

For a lower speed, two complete trains could be in use giving a 25 : 1 reduction, while for the higher speed the planet wheels of the second train could be removed and some form of direct coupling between the two carriers provided.

I am taking this opportunity of writing you in case other readers are proposing to make a hand-drill and might care to try out this idea. If two trains are to be used, the internally-toothed ring would have to be left rather longer than as suggested by Mr. Law; also, the drill should then take up to $\frac{3}{8}$-in. drills and a larger chuck could be used.

Yours faithfully,
London, W.C. F. MOSS.

The Southampton Exhibition

DEAR SIR,—With reference to the account of the Southern Federation meeting, in the May 5th issue of THE MODEL ENGINEER, I should, as the recorder of the Minutes, like to correct an error that has crept into the statement by Mr. Williamson regarding the model engineer show by the Southampton club.

At the meeting a statement was made by one of our members that it was *hoped* to ask either Lord Louis Mountbatten or Admiral Viscount Cunningham to open the show, as it was for the benefit of King George's Fund for Sailors. We were aware at the time that Lord Louis Mountbatten was not in this country, but as the date of the show was put back, we had hopes of either of these great sailors.

Incidentally, "our show," for reasons beyond our control, is now a part of the Southampton Model Homes, Industrial and Fashion Exhibition, and will continue until June 4th.

I hope I have made it clear that our show is not on June 10th and is *not* to be opened by Lord Louis Mountbatten. The charity mentioned will still benefit.

Yours faithfully,
Southampton. A. W. TRUSSLER.

Corrigendum

DEAR SIR,—*Re* the photographs which appear on the cover and in THE MODEL ENGINEER of my steam tug *Lady Marion* and the write-up appearing in the same issue, I am most concerned about the wrong report that was given you concerning the builder of the tug and paddle steamer, *Lady Betty*. At no time have I claimed to be their builder, but the facts are that I purchased the tug hull, etc., and rebuilt her to her present condition to conform to the prototype of the ocean-going tug stationed at the Avonmouth docks; also, *Lady Betty*, as Mr. Westbury will know, was built by Mr. Frank Spinks, also a Harrow S.M.E. member, and I purchased this boat from him and reconditioned her.

Yours faithfully,
Pinner. S. R. EMERY.

Risks in Remelting Castings

DEAR SIR,—I recently purchased some ex-W.D. surplus instruments for a few shillings. These I broke down, and after salvaging the gears and ball-bearings, decided to melt down the metal castings, for an o.h.c. petrol engine I am building. Having made my dies, etc. for this engine, I started to run these old castings down for my crankcase.

Fortunately, it being a nice day I did this outside. Imagine my surprise when the ladle full of near molten metal ignited with a brilliant, dazzling glare. Remembering my old sergeant's advice on dealing with fire-bombs, I promptly shovelled dirt on the whole lot (good old Sarge !). Anyway it worked, and the fire was soon under control.

Evidently these small but beautifully detailed castings have a very high magnesium content.

So I reckon that I was doubly fortunate, first in melting them down *outside* the house (I hate to think what might have happened if it had been raining, and I was working inside) ; and secondly in recognising the flare as magnesium, and thereby using *dirt* instead of throwing a bucket of water over it, which only seems to break it up and shoot it over a wider area.

My object in writing to you is to bring to notice the dangers that can arise through melting down these innocent looking castings.

Yours faithfully,

Leyton. G. W. PALMER.

The Double Slide-valve

DEAR SIR,—I have read, with considerable interest, Mr. Austen-Walton's article on "A Double Slide-valve Design," which appeared in the issue dated April 28th. After giving the matter careful thought, I have come to the conclusion that the scheme contains a pitfall for the unwary. An advantage of the scheme, it is said, is the arched exhaust cavity which it makes possible. Herein, however, lies a danger ; with ports of conventional proportions, and with the valve cavity arranged as shown, also assuming the use of a conventional lap, serious restriction of the exhaust port by the edge of the exhaust cavity, remote from the steam port, will commence to take place with a travel giving about 40 per cent. cut-off. If one wishes to use a late cut-off of about 80 per cent., the exhaust port will be completely closed at one point during the exhaust stroke. As I see it, the only really safe course is to provide an exhaust cavity equal in size to that used with the normal slide-valve.

I do not wish to be unduly critical of Mr. Austen-Walton's proposal, but I fail to see why the design permits the use of an unusually narrow valve. Although I have, as yet, no personal experience in these matters, I am under the strong impression that the significance of width in the slide-valve is the maintenance of reasonable areas of port opening at early cut-offs.

Yours faithfully,

Croydon. H. W. HOLMES

CLUB ANNOUNCEMENTS

The Faversham and District Model and Experimental Engineering Society

Mr. H. Herbert (member) gave a very interesting talk and demonstration on the building of miniature compression-ignition engines at our meeting on April 7th.

Major W. H. Agar, A.M.I.E E., was to have lectured on "The Electric Lamp" at our meeting on May 5th but owing to pressure of business was unable to do so. Instead Mr. A. B. Neal, A.M.I.Mech.E. (past chairman), lectured on "Horse Power." Major Agar's lecture is now fixed for June 2nd.

On June 30th a talk on "The Internal Combustion Engine" will be given by Mr. T. A. Grove (chairman).

Hon. Secretary: R. W. PARTIS, 14, Edith Road, Faversham, Kent.

Deeside Model Engineering and Crafts Society

A model aircraft section has now been formed with an ever-growing membership, efforts are being made to organise competitions, insurance cover, etc.

Preparations are now going ahead for the society's exhibition to be held in the County Primary School, Shotton, on Friday, June 10th, from 5 p.m. to 10 p.m., and Saturday, June 11th from 10 a.m. to 8 p.m. In addition to the usual passenger-carrying track, model race cars and control-line aircraft will be demonstrated at intervals. Offers of support from other clubs and individuals will be most welcome.

Hon. Secretary: S. BLYTH, "Harfield," 57, Caernarvon Close, Shotton, nr. Chester.

Sutton Coldfield and North Birmingham Model Engineering Society

We are glad to report that the society is in a very healthy state. New members continue to come along, and the membership is now 42 strong.

Programme for June includes :—

June 7th. "Bits and Pieces" Night.

June 21st. Sheet-metal work night. Members are invited to "have a go" by expert member, Jack Orme.

Meetings are held on alternate Tuesdays, at the Station Hotel, Station Street, Sutton Coldfield.

Hon. Secretary: C. F. PALMER, 77, Hartley Road, Kingstanding, Birmingham, 23.

Brighton and District Society of Model and Experimental Engineers

The meeting of this society on May 9th was devoted to the business of the annual general meeting. Mr. Hebblethwaite the retiring chairman, gave a report of a successful year's working and when pressed to accept office for a further year, he regretfully declined for personal reasons. Mr. Wiel, a long standing and valued member was elected the new chairman. Mr. Achard was given a hearty vote of thanks for his efficient services as hon. secretary and unanimously elected for a further year of office. An interesting programme is being drawn up for the summer season, and an added attraction is the club's new 250-ft. multi-gauge track at Withdean, where members are invited to run their locomotives at any time.

Hon. Secretary: H. G. ACHARD, 48, Aldrington Avenue, Hove 4, Sussex.

Vickers-Armstrong Limited (Weybridge) Social and Athletic Club

The annual fete and gala will be held on the Sports Ground, on Saturday, June 18th. There will be the usual exhibition of models of all kinds, the competition section of which will be open to members of all model engineering clubs and individuals not connected with the model trade or profession. For the purposes of judging, the entries will be grouped in six sections, viz.: aircraft, cars, general engineering, locomotives, power boats and sailing boats.

Experts in these sections will comprise the Panel of Judges, and awards will be cash vouchers, cash prizes, medals and diplomas in all sections, governed by the number of entries. Entry fee will be 6d. per model. Entry forms are available from the Hon. Secretary, W. H. PLEDGER, 32, Lindsay Road, Woodham, Weybridge, Surrey. Closing date is June 14th.

Models for the loan section will be most welcome. Enquiries about the exhibition should be addressed to Mr. W. Titcombe, "Keston," High Road, Byfleet, Surrey. Tel.: Byfleet 2102.

Locomotive owners will have the track at their disposal for passenger-carrying.